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A wild and wonderful world awaits you inside!

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SEND IT IN!

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TN11 8PS

FACTopia!

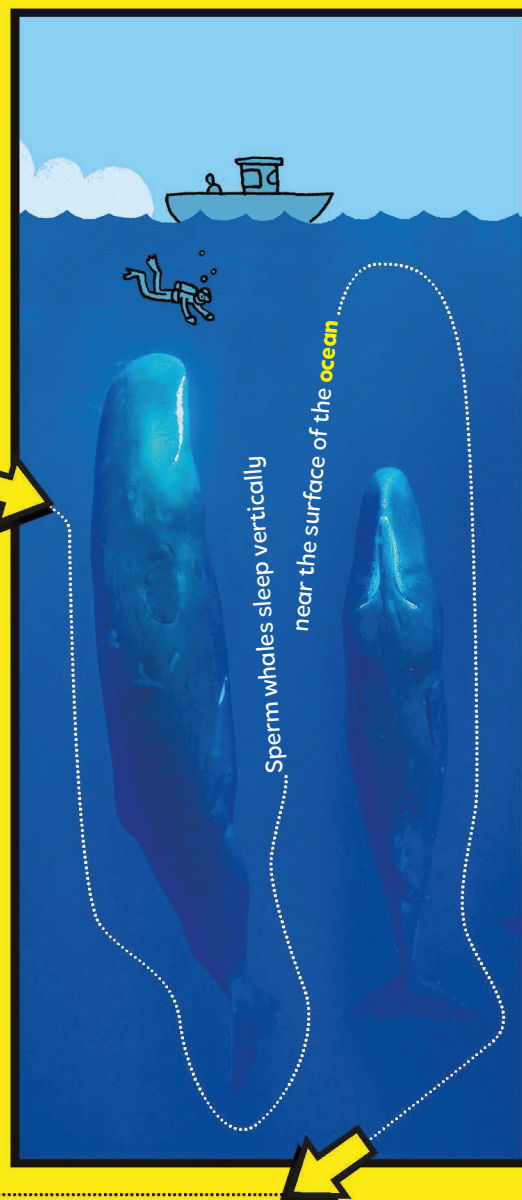
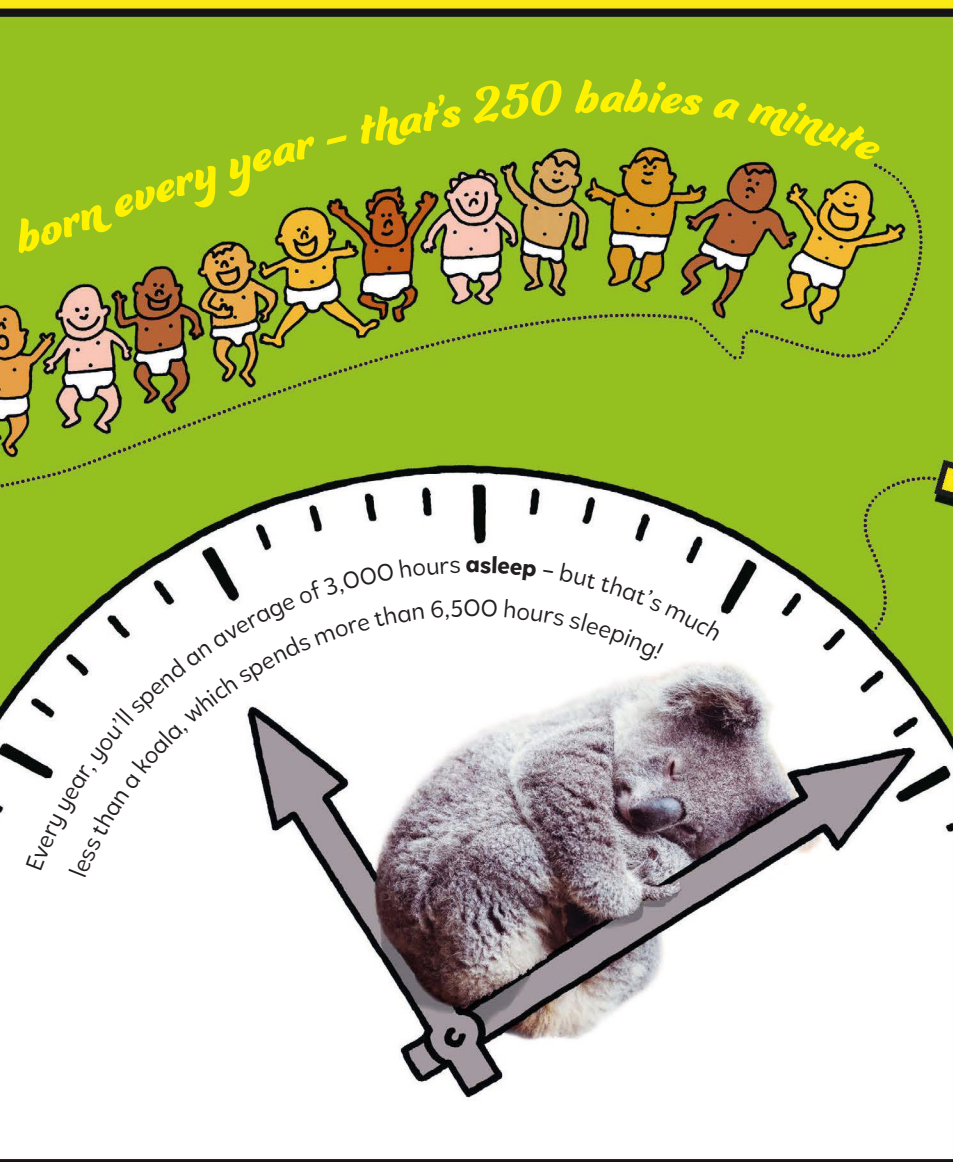
Follow the trail of crazily connected facts all the way from colourful chameleons to... a hand of bananas!

By Kate Hale and Julie Beer
Illustrations by Andy Smith

born every year – that's 250 babies a minute
Every year, you'll spend an average of 3,000 hours **asleep** – but that's much less than a koala, which spends more than 6,500 hours sleeping!

Sperm whales sleep vertically near the surface of the **ocean**

According to legend, bringing a **banana** on a boat is bad luck
hollowed-out pumpkins

Banana plants aren't trees – they're a **herb** related to ginger
Scientists have done studies to show how SLIPPERY banana peels are
Bananas are naturally **radioactive** – but you'd have to eat at least a billion in one meal to consume a deadly dose
A single banana is called a **finger**, while a group of bananas is called a **hand**!

SNAP IT!
Astonishing photos from around the world

FOLLOW YOUR NOSE!

Did you know that an elephant's trunk contains more than 40,000 muscles and is strong enough to pick up a tree? Elephants also use their trunks to suck up drinking water – and as snorkels!

CREDIT: SULIMAN ALATIQI / UPY 2023

SNAP IT!

CAUGHT ON CAMERA

Snow leopards are very difficult to photograph in the wild because they live in remote mountain regions and are wary of humans. This stunning image was taken by a 'camera trap' left on the mountainside which automatically took a photo when the snow leopard walked past.

WILDLIFE PHOTOGRAPHER OF THE YEAR 2023 / SASCHA FONSECA

WORLD OF BOOKS

People say that reading a book transports you to another world, and that feels especially true at the Zhongshuge bookshop in China. The spiral effect was created by converting a spiral staircase into a bookcase and then laying it on its side.

LIFE'S A PICNIC

The Big Basket was originally built to be the headquarters of the Longaberger Company and designed to resemble the US company's best-selling product, the Medium Market Basket. There are now plans for it to be used as a hotel.

FLY YOU WILL NOT

The annual Birdman Rally in Melbourne, Australia, challenges would-be aviators to jump off a platform and fly. Sadly but hilariously they never succeed. This brave contestant took off while hanging beneath a polystyrene replica of an X-wing from *Star Wars*. The Force wasn't with him, however, and both pilot and X-wing ended up crash-landing in the river!

Eureka!

The latest astonishing discoveries, inventions and scientific breakthroughs.

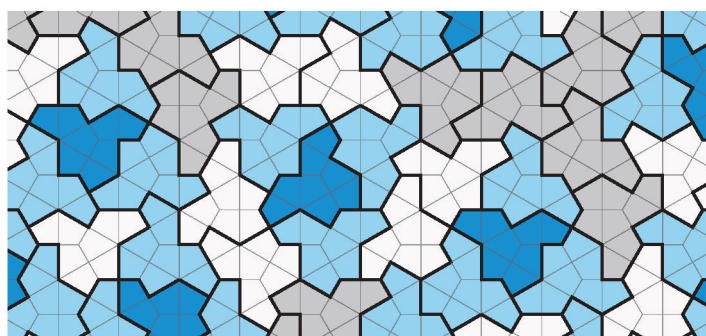
Getting to know the inner tiger

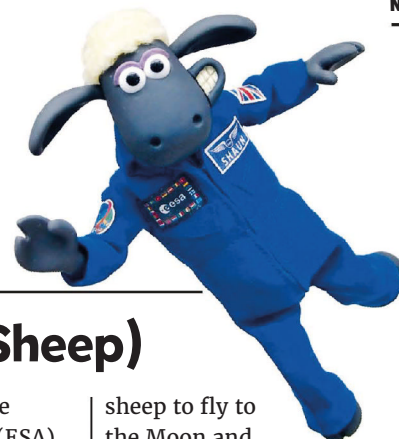
Psychologists sometimes group human beings into different personality types that partly describe the kind of person someone is. For example, humans can be roughly grouped into extroverts, who are more expressive and outgoing, and introverts, who are more focused on their inner thoughts and ideas.

New research suggests that Siberian tigers can be grouped into two personality types, too: ‘majesty’ and ‘steadiness’. Tigers with majesty ranked higher in group status and were more confident. Tigers showing steadiness were more relaxed and less aggressive. Majestic tigers also liked to eat more food!

The amazing tiling pattern that NEVER repeats!

If you take a simple geometric shape – such as a square – and place a series of those shapes alongside each other, they will form a repeating pattern, like tiles on a bathroom wall. Another good example of this tiling effect is bees’ honeycomb, which forms a repeating pattern using lots of individual hexagons.

For many years, experts in mathematics wondered whether a single shape of tile existed that could be used to completely cover a surface without EVER creating a repeating pattern.

Now, after decades of trying, they have finally found one! The new 13-sided shape, which is highlighted with thick black outlines in the illustration above, is known as ‘the hat’.

Chaim Goodman-Strauss says he and a team of mathematicians at the University of Arkansas, USA, used a combination of computer programs and human brainpower to discover this extraordinary new shape. ‘You’re literally looking for a one in a million thing,’ he says. Scientists think that the newly discovered ‘hat’ shape could be used to design very strong materials – as well as for tiling maths professors’ bathrooms!

A giant leap for lamb-kind (and Shaun the Sheep)

Shaun the Sheep, pictured right, has returned to Earth after taking part in an epic space mission to the Moon.

The stop-motion animation character joined a NASA crew on a lunar space journey that covered almost 2.5 million kilometres before the capsule holding NASA's astronauts (and a 16cm-tall model of Shaun) splashed down in the Pacific Ocean.

Shaun earned his astronaut wings as a mascot for the European Space Agency (ESA), which had provided the module that propelled the capsule forward on its 25-day journey.

ESA's director of exploration, David Parker, said: 'As the first sheep to fly to the Moon and back, Shaun's got a lot to teach us about the ambition, talent and diversity needed for the exploration of space.'

New emoji released for King Charles's #coronation

King Charles III and Queen Camilla will officially be crowned on May 6th at Westminster Abbey in London, as part of a 1,000-year-old ceremony that will be watched on TV by millions of people around the world.

To help celebrate, a new crown emoji has been released. Its design is based on St Edward's Crown, which was made for Charles II in 1661. As well as featuring more than 400 precious and semi-precious stones, the crown is made of solid 22-carat gold and weighs 2.23 kg, which is roughly the same as a brick.

To find out more fascinating facts about some of the great kings and queens from British history, turn to the giant timeline on page 26.

What sounds do you find annoying?

Loud chewing. Fingernails scraping down a blackboard. Snoring. Lots of everyday sounds can be annoying and, according to new research, one in five people in the UK find at least one common noise completely unbearable. Scientists call this strong negative emotional or physical reaction to an everyday sound misophonia. The word comes from the Ancient Greek words for hate (*misos*) and sound (*phónè*). The researchers say more study into misophonia is needed so that scientists can understand the condition better and help those who suffer from it.

Meet DribbleBot, a robot that plays football!

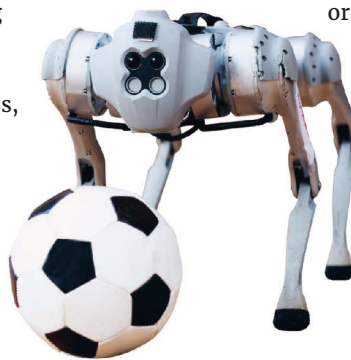
It might not have the dizzying skills of Lionel Messi, but DribbleBot is the world's first footballing robot capable of dribbling a football on grass, sand, gravel – and even snow!

The four-legged AI robot has been designed to run across uneven ground and a variety of surfaces while dribbling, or controlling, a football.

Before it started to practise in the real world, DribbleBot 'trained' by running a digital simulation of its task for hundreds of days to learn the best way to run and control the football at the same time.

Scientists hope that the same technology will one day be used to build AI robots that can help humans in disaster zones, where the landscapes are often uneven and so impossible for wheeled robots to travel across.

LISTIFIED!

Prepare to be amazed (and amused!) by the unusual facts crammed into these irresistible lists.

GOING UP

Six things that happen to the body when it is climbing at high altitude

When climbing a mountain, the higher you go, the 'thinner' the air becomes because the oxygen molecules are more spread out. Here's how travelling to great heights can affect the body:

Climbers on Mount Everest, which is 8,849 metres above sea level.

1 Heavy breathing

Above 1,500 metres, your body responds to the reduced levels of oxygen in the atmosphere by automatically breathing more quickly and deeply, and by pushing air to parts of the lungs that aren't normally used.

2 Red blood cell production

Your heart beats faster and your body produces more red blood cells, which transport oxygen, as well as an enzyme that helps oxygen make its way into body tissues.

3 Toilet breaks

To make room in the body for new red blood cells, the kidneys work faster to flush out fluids from the body as wee. Inconveniently, this means you have to go to the toilet more often!

4 Weaker muscles

Because less oxygen is reaching the muscles, exercise and physical effort are more difficult at this height.

5 Altitude sickness

At about 2,500 metres, the body can suffer serious symptoms of altitude sickness.* These symptoms include headaches, feeling sick and a loss of appetite and coordination. The only cure is rest and giving the body time to get used to the change in oxygen levels.

6 High-altitude sickness

At about 5,500 metres, fluid can build up in the lungs and, even more seriously, inside the brain. This is caused by higher blood pressure forcing fluids out of the blood vessels and into other parts of the body. High-altitude sickness is very dangerous and can be fatal if it is not treated immediately by returning to a lower altitude, taking special medicine or breathing bottled oxygen.

*Aeroplanes fly much higher than this, at round 10,000 metres. However, you don't suffer from altitude sickness when flying in an aeroplane because the air pressure and oxygen levels inside the plane are controlled.

GOING DOWN

Six things that happen to the body when diving without a wetsuit*

1 Diving reflex – at the surface

As soon as your face comes into contact with cold water, it triggers a diving reflex. This sends more oxygen to the vital organs – the heart and brain – and less oxygen to the hands and feet.

2 Heart slows – 1 metre deep

The diving reflex makes your heart beat between 10 and 25 per cent slower. A slower heartbeat helps to preserve oxygen, which is carried in the blood. This is useful because there is no new oxygen to breathe in.

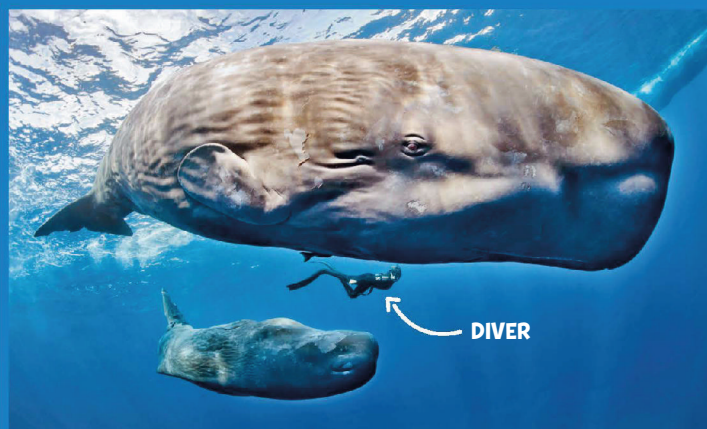
3 Eardrums may burst – 4 metres deep

You start to feel the water pressure in your ears at a depth of 30 centimetres. At depths of 4 metres and more, it is possible that the increased water pressure will cause your eardrums – a thin membrane inside each ear – to burst.

4 Lungs shrink – 10 metres deep

As you go deeper, pressure squeezes your lungs and compresses the air inside. At a depth of 10 metres, your lungs are half the size they were at the surface.

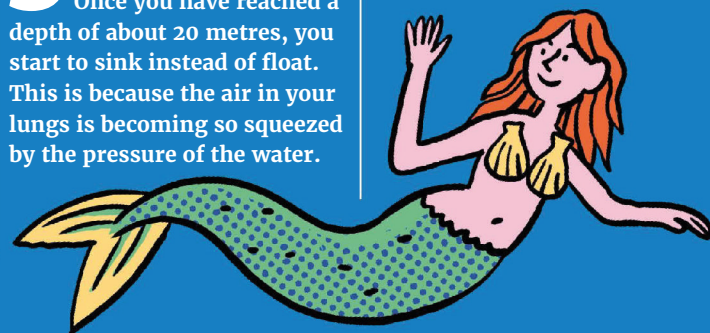
5 Body sinks – 20 metres deep

Once you have reached a depth of about 20 metres, you start to sink instead of float. This is because the air in your lungs is becoming so squeezed by the pressure of the water.

A scuba diver in a wetsuit swims between two sperm whales.

6 Tricks of the mind – 30 metres+ deep

At this depth, you can experience 'nitrogen narcosis' – a feeling of sleepiness and mixed-up thinking also known as the 'rapture of the deep'. Deep-sea divers sometimes think they see things that are not there – even mermaids!

*When a human dives underwater, the weight of water presses down on the body. Divers wear an 'atmospheric diving suit' to protect against these effects.

Listified!, *written by Andrew Pettie and illustrated by Andrés Lozano, is out now.*

TOP SECRET

SPY GAMES

YOUR MISSION: READ THIS SPECIAL REPORT TO FIND OUT WHAT IT TAKES TO BECOME A SECRET AGENT

INSIDE

- FAMOUS SPIES
- SECRET CODES
- HOW TO BECOME A SPY
- SPY ANIMALS
- SPY GADGETS
- PUZZLES

WHAT IS A SPY?

A spy is a person whose job it is to find out secret information. Governments, businesses and other organisations hire spies.

The nature of a spy's job means that they prefer to work in secret and try to keep others from finding out who they are and what they do. Whether a spy is trying to discover what a wartime enemy is planning to do next, or find out about a product a rival business is developing, spies generally gather information that people cannot get in ordinary or legal ways.

Spies may buy or steal secret information from people. They may use sneaky gadgets, like the ones on page 20, and other technology to gather information. When they've gathered the secret information, spies often communicate it to others using secret codes and ciphers, like the ones on page 22.

5 FAMOUS REAL-LIFE SPIES

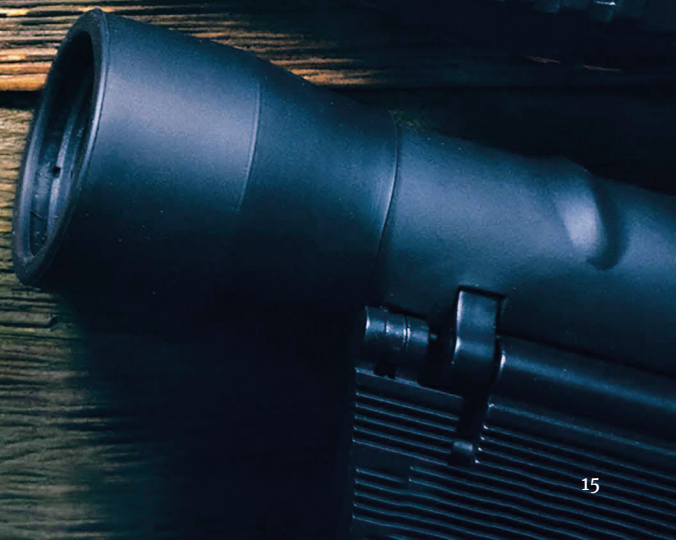
SPY: DUSAN POPOV

CODENAME: Tricycle

BORN: 10 July 1912

DIED: 18 August 1981

NATIONALITY: Serbian

DETAILS:
Born in Serbia in Eastern Europe, Dušan 'Duško' Popov worked as a secret agent for Britain's foreign intelligence service, MI6, during the Second World War. During his career, Popov worked alongside Ian Fleming, a British Naval Intelligence Officer who later became an author. Popov was known for his daring exploits and charm, and is thought to be one of the main inspirations for James Bond, the fictional British spy who Fleming created.

A LETTER INFORMING US PRESIDENT HARRY TRUMAN ABOUT VIRGINIA HALL'S MEDAL FOR HEROISM DURING WWII

MEMORANDUM FOR THE PRESIDENT:
Miss Virginia Hall, an A…
this agency in the European Th…
awarded the Distinguished Ser…
heroism in connection with mi…
enemy.
We understand that Miss Hall is the first …
woman in this war to receive the Distinguished Service Cross.
Despite the fact that she was well known to the Gestapo,
…
Resistance Forces in the Haute Loire Department, transmitt…
and receiving operational and intelligence information. This
… the enemy, whenever

SPY: JAMES ARMISTEAD LAFAYETTE

BORN: around 1748

DIED: 1830

NATIONALITY: American

DETAILS:
Born into enslavement, James Armistead volunteered to join the US Army to fight against the British in the Revolutionary War. Posing as a freedom seeker, Armistead managed to gain access to the headquarters of British general Charles Cornwallis. He then worked as a double agent, passing details of the British army's plans to the Americans. This information proved crucial in the American victory at the Siege of Yorktown. Armistead gained freedom from enslavement in 1787.

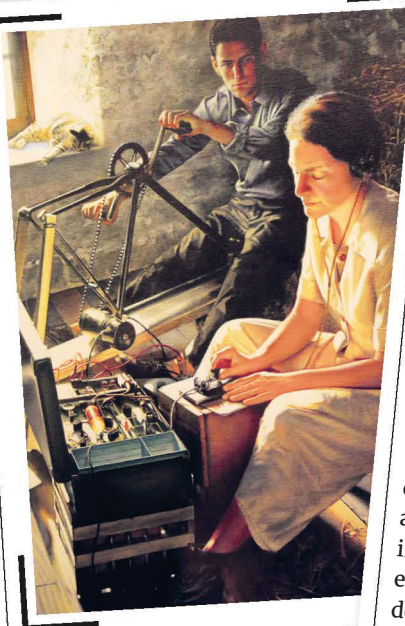
SPY: VIRGINIA HALL

ALSO KNOWN AS: The Limping Lady

BORN: 6 April 1906

DIED: 8 July 1982

NATIONALITY: American

DETAILS:
Born in the US, Virginia Hall worked for the Special Operations Executive, an underground army that fought in secret for Britain and its Allies within countries Germany had occupied during the Second World War. Hall was described on the Germans' 'most wanted' list as 'the limping lady' because she had a prosthetic leg that gave her a distinctive limp. Hall used this prosthetic limb, which she named Cuthbert, to hide secret documents. She continued to work as a spy after the war.

SPY: SIR FRANCIS WALSINGHAM

ALSO KNOWN AS: Spymaster General

BORN: around 1532

DIED: 6 April 1590

NATIONALITY: English

DETAILS:
Sir Francis Walsingham ran a network of spies for Queen Elizabeth I. Walsingham was an important figure in Tudor England, who recruited many paid informers and cryptographers (who are experts in creating and solving secret codes) in order to collect information that would protect the Queen. His efforts are thought to have helped England to defeat an invading Spanish Armada in 1588.

SPY: ANNA CHAPMAN

ALSO KNOWN AS: Anna Kushchenko, Anya Kushchenko, Anya Chapman

BORN: 23 February 1982

NATIONALITY: Russian

DETAILS:

Anna Chapman – who was born in the Russian city of Volgograd as Anna Kushchenko – was arrested in the United States in 2010 and accused of being a member of a spy ring working for the SVR, Russia's foreign intelligence agency. Chapman pled guilty at her trial and was later sent home as part of an exchange of prisoners between the United States and Russia. After returning to Russia, she has become a well-known public figure, once even hosting her own weekly TV show.

JAMES ARMISTEAD LAFAYETTE, RIGHT, WAS A DOUBLE AGENT DURING THE AMERICAN REVOLUTIONARY WAR

WHAT IS A DOUBLE AGENT?

Some spies pretend to work for one government or business while actually spying on it for another government or business. These spies are called double agents or moles.

It is even possible for a spy to become a triple agent by pretending to be a double agent for one side while actually being a double agent for the other. What a confusing job!

TOP SECRET

ANIMAL SPIES

SPY PIGEONS

During both the First and Second World Wars, spy pigeons were fitted with small cameras that took pictures of battlefields and other military targets from above. A camera would be strapped to a carrier pigeon's breast and programmed to automatically take hundreds of photographs as the pigeon flew over the targets.

THE CIA'S "ACOUSTIC KITTY" PROJECT

'Acoustic Kitty' was a project launched in the 1960s by the CIA, the United States' Central Intelligence Service, to turn cats into sneaky listening devices. A vet would place a tiny microphone inside the cat's ear to listen in on secret conversations and a small radio transmitter at the base of its skull to send them back to the cat's handlers. Acoustic Kitty's first ever mission was to eavesdrop, or listen in, on a conversation between two men in a park. Sadly, the cat was reportedly hit and killed by a taxi almost immediately. The entire Acoustic Kitty project, which is said to have cost the CIA millions of dollars, was cancelled in 1967.

Antenna wire on the cat's back

Microphone inside the cat's ear

Radio transmitter and power supply

USING CODES

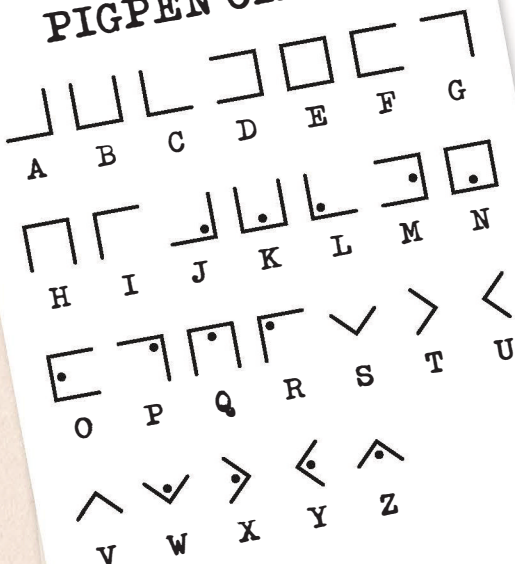
MORSE CODE

Morse Code is a system of communication that was invented in the 1830s by the American artist and inventor Samuel Morse. It uses dots, dashes and spaces to represent letters, numbers and punctuation. Morse Code was originally designed as an electronic form of communication. A machine called a telegraph converts the code into a series of electrical signals which are then converted back into the original message by the telegraph that receives them.

Morse Code was a key form of communication used by both intelligence agencies and the military during the Second World War, when it was used to transmit important messages, most of them already written in other secret codes.

PIGPEN CIPHER

Pigpen cipher, which is also known as tic-tac-toe cipher, is an ancient code that has been used to send and receive messages for centuries. Each letter of the alphabet is replaced by a symbol (shown below). If you turn to page 22, you can try decoding messages written in pigpen for yourself...

MORSE CODE

Letter	Code	Letter	Code	Number	Code
A	•–	N	–•	1	•––––
B	–•••	O	–––	2	••–––
C	–•–•	P	•––•	3	•••––
D	–••	Q	––•–	4	••••–
E	•	R	•–•	5	•••••
F	••–•	S	•••	6	–••••
G	––•	T	–	7	––•••
H	••••	U	••–	8	–––••
I	••	V	•••–	9	––––•
J	•–––	W	•––	0	–––––
K	–•–	X	–••–		
L	•–••	Y	–•––		
M	––	Z	––••		

THIS SECRET RAF BASE MONITORS ELECTRONIC COMMUNICATIONS FOR THE UK AND US INTELLIGENCE AGENCIES

GCHQ, THE HEADQUARTERS OF THE UK'S INTELLIGENCE AND SECURITY AGENCY, IS KNOWN AS 'THE DOUGHNUT'

GERMAN SOLDIERS USING AN ENIGMA MACHINE TO SEND CODED MESSAGES DURING WWII

ENIGMA MACHINE

The Enigma machine was used by the German military to encode important messages before and during the Second World War. Although the machine looks a bit like a typewriter, hidden inside it is a fiendishly complex system involving dozens of gears and rotors.

A number of Allied code-breakers – including the Polish mathematician Marian Rejewski and a team led by the British mathematician Alan Turing that was based at Bletchley Park in the UK – worked tirelessly to decipher the Germans' coded messages. Their success in cracking the Enigma code is thought to have hastened Allied victory in WWII – saving millions of lives.

KRYPTOS

During the 1990s, America's Central Intelligence Agency, known as the CIA, set a challenge for its own agents. The agency installed a large wavy sculpture (pictured right) in the grounds of its headquarters in Langley in Virginia, USA.

The sculpture contains a long list of letters and symbols that form a complex four-part code. The title of the sculpture, Kryptos, is appropriate because it is the ancient Greek word for hidden. To date, only three parts of the Kryptos code have been solved. So if you would like to work for the CIA as a codebreaker, solving the fourth and final part would be a great place to start!

RSA ENCRYPTION

RSA encryption, which is named after the surnames of its inventors, Ronald L. Rivest, Adi Shamir and Leonard M. Adleman, is a way of encoding digital information. Today it is used to make most electronic communications, such as e-mail, and digital transactions over the Internet private and secure.

RSA uses a computer algorithm to both code and decode electronic messages. Although some computer scientists think it is theoretically possible to crack RSA encryption, so far the coding system has yet to be broken.

WHAT IS CYBER SPYING?

People have been spying on each other since ancient times. The ancient Egyptians and Chinese used spies more than 2,000 years ago. In Europe, kings and queens nearly always had spies. Today, a lot of modern spy work is carried out with the help of digital technology, including spy drones and satellites, and hackers that steal secrets from other computers via the Internet. This is called cyber spying.

REMOTE-CONTROLLED DRAGONFLIES

In 1974, the CIA introduced the insectothopter, a remote-controlled dragonfly designed to secretly record people's conversations. The extraordinary insect was powered by a tiny gas engine and was only able to operate for 60 seconds at a time. It also struggled to fly in strong winds and so was never used on a proper mission. However, the insectothopter did show that drones had an important role to play in the future of spying.

LIPSTICK GUN

In 1965, American officials arrested and searched a person acting suspiciously at an inspection point in West Berlin, Germany. They found a normal-looking lipstick holder. But when they opened its case, they realised it was actually a 4.5 mm pistol capable of firing a single bullet. The weapon, nicknamed 'Kiss of Death', is now on display at the International Spy Museum in Washington DC, USA. Disguised guns were often used by Soviet agents during the Cold War.

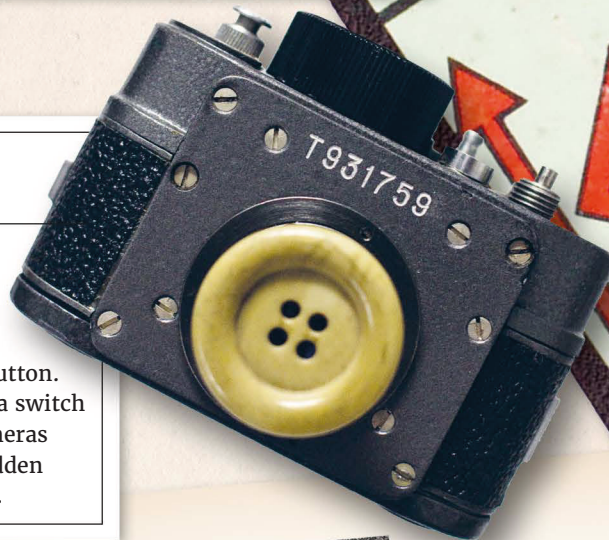
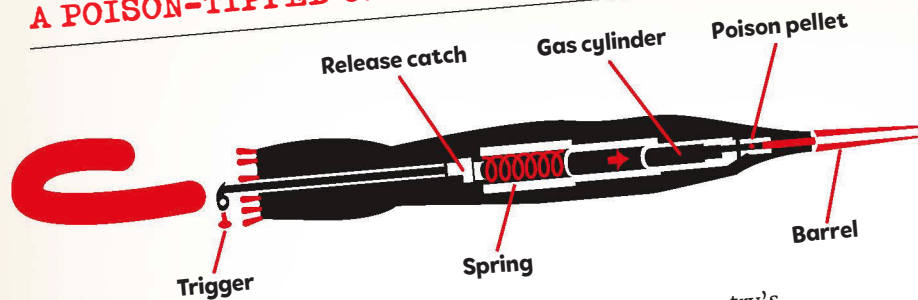
WRISTWATCH CAMERA

In the late 1940s, West German engineers developed a miniature spy camera that was disguised as a wristwatch. This was decades before the invention of digital cameras so concealed beneath the camera's lens was a tiny roll of photographic film that was capable of taking eight photographs. Secret agents would carefully aim the wristwatch camera while pretending to check the time and then press a small button on its side to take a photo.

MONOPOLY SETS TO HELP WWII PRISONERS ESCAPE

During WWII, compasses and maps were hidden inside special versions of the board game Monopoly. The games were sent by fake charities to Allied prisoners to help them escape. A secret code was even hidden within the game so that it would be passed on to prisoners in the correct location. A full stop after Marylebone Station, for example, was code for 'Italy'. A full stop after Mayfair meant 'Norway, Sweden or Germany'.

A CAMERA HIDDEN BEHIND A COAT BUTTON

Miniature cameras were used by spies working for the United States and the Soviet Union throughout the Cold War (1947-1991). Some models were small enough to be concealed behind a jacket button. The spy would operate the camera using a switch hidden in the coat's pocket. Tiny spy cameras and miniature microphones were also hidden by the CIA inside necklaces and brooches.

A POISON-TIPPED UMBRELLA

Georgi Markov, a Bulgarian writer who was critical of his country's Communist government, was walking across a bridge in London in 1978 when he felt a sharp pain in his leg. Four days later, Markov was dead. Doctors examining his body found a tiny metal pellet inside his leg that many people think was fired by a poison-tipped umbrella.

SPY ROCK

The British government has admitted using a transmitter hidden inside a fake plastic rock to spy on people in Russia. The plot was exposed on Russian TV when a documentary showed a video of one man kicking the rock and another walking past the rock and picking it up. X-rays revealed that the hollowed-out rock contained electronic wires and circuits. Four British men and one Russian man were accused of using the hidden transmitter to download secret information.

ONE OF THE SNEAKIEST SPY CAMERAS OF ALL TIME WAS HIDDEN INSIDE A NEW PHOTOCOPYING MACHINE BEFORE IT WAS DELIVERED TO A FOREIGN COUNTRY'S EMBASSY. SO WHENEVER STAFF AT THE EMBASSY USED THE MACHINE TO PHOTOCOPY A TOP SECRET DOCUMENT, THE SPY CAMERA TOOK A PICTURE AT THE SAME TIME!

CHECKLIST FOR ASPIRING SPIES

Has reading this report inspired you to become a spy? Here are four things you can do right now to prepare for a career in the intelligence services.

1. DON'T DO ANYTHING TOO NAUGHTY!

In order to get a job at an intelligence agency, most applicants have to go through a tough interview and selection process. This includes background checks to see if applicants have good judgement, are reliable and have behaved well in the past.

2. WORK HARD AT SCHOOL

Working as a spy requires intelligence and discipline, and successful applicants usually need good grades at school and, in many cases, a university degree. Popular subjects for aspiring spies to study include law, computer science, psychology and international relations.

3. LEARN A FOREIGN LANGUAGE

Many spies work in foreign countries. So the ability to speak fluently with locals could be essential if the mission involves assuming the identity of someone from the country in which you are posted.

4. KEEP FIT AND HEALTHY

As well as IQ tests and interviews, the application process for most intelligence agencies also includes a physical test to ensure would-be spies are in excellent physical condition. So remember to keep fit and healthy, as you never know when you'll need to run, jump or swim to evade capture by the enemy!

THE HEADQUARTERS OF THE UK'S FOREIGN INTELLIGENCE SERVICE, MI6.

SPY PUZZLES & GAMES

Do you have what it takes to become a secret agent? Test your spying skills with these top secret puzzles and code games.

CRACK THE CODE

A) Use Morse code to decipher the names of these five cities:

1) — .- -.. .-. .. -..

2) .-.. --- -. -.. --- -.

3) - --- -.- -.-- ---

4) .--. .- .-. .. ...

5) -. . .-- / -.-- --- .-. -.-

B) Use pigpen cipher to decipher the names of these five animals:

1)

2)

3)

4)

5)

FIND THE FOOD

A word for a type of food is hidden somewhere within each of the following five words. Can you find the edible words?

A) C H A M E L E O N

B) B E G G A R

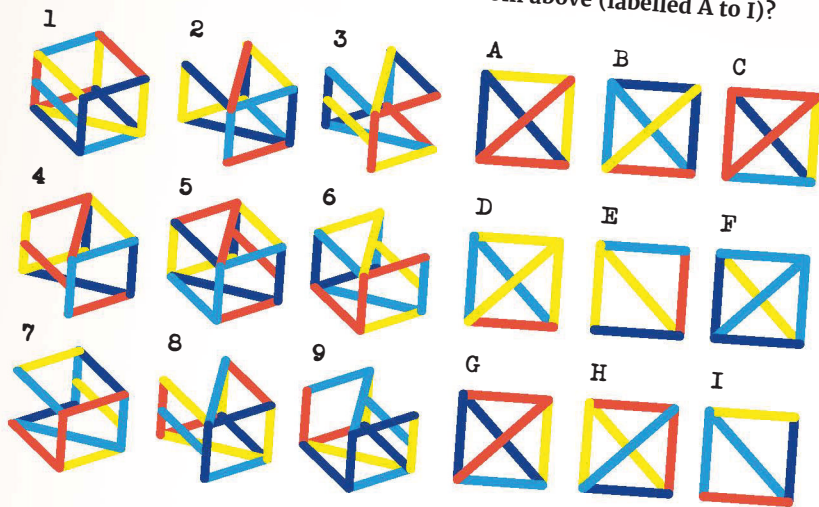
C) P L U M A G E

D) T R I C E R A T O P S

E) S T A R T L I N G

ANSWERS ON PAGE 50

VIEW FROM ABOVE

Nine three-dimensional shapes are drawn below. If you were to look at a 3D shape from above, it appears to form a multi-coloured square with diagonal lines connecting the corners. Can you pair the 3D shapes (labelled 1 to 9) with the views of them from above (labelled A to I)?

MIRROR IMAGE

Can you spot which pair of keys are mirror images of each other?

MATCHSTICK MATHS

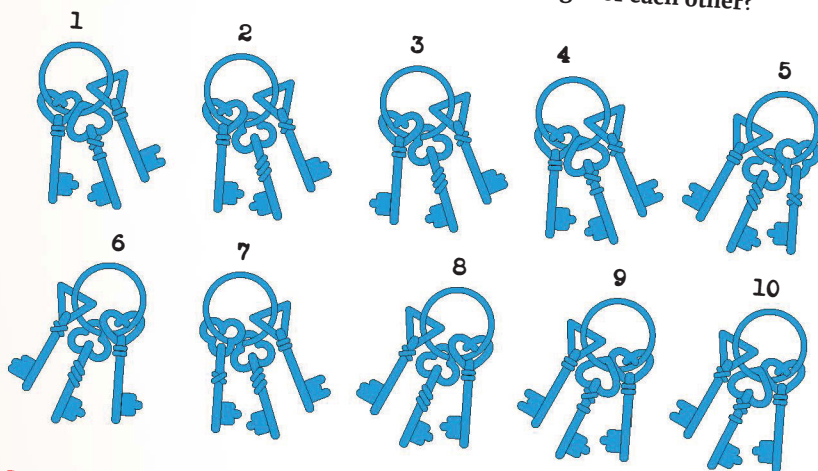
The numbers and symbols in the following five sums have been made from matchsticks. However, at the moment, the sums are incorrect. In each case, move ONE matchstick to another position within that sum so that it is now correct. Remember, the matchstick can be taken from and added to a number or taken from and added to a mathematical symbol.

1)

2)

3)

4)

5)

TURN THE COGS

Cogs can be linked together to form a machine, as in the illustration below. Cogs can either turn clockwise or anticlockwise. If a cog turns clockwise, then the next cog in the machine will turn anticlockwise. And if a cog turns anticlockwise, then the next cog in the machine will turn clockwise.

If the cog labelled START HERE turns clockwise, can you work out which ways the cogs labelled A, B, C and D will turn?

INSIDE A TORN

Tornadoes, which are also known as twisters, spin down from giant thunderclouds. Roaring like a train, they rip across the landscape at speeds of between 48 and 113 kilometres per hour (km/h), tearing down buildings, uprooting trees, and hurling cars in the air. Winds spiral around a tornado at 105–482 km/h or more, creating a centre of low pressure that can suck up objects like a vacuum cleaner does...

Supercell cloud where the tornado develops.

Spiral bands of thunderclouds bring torrential rain.

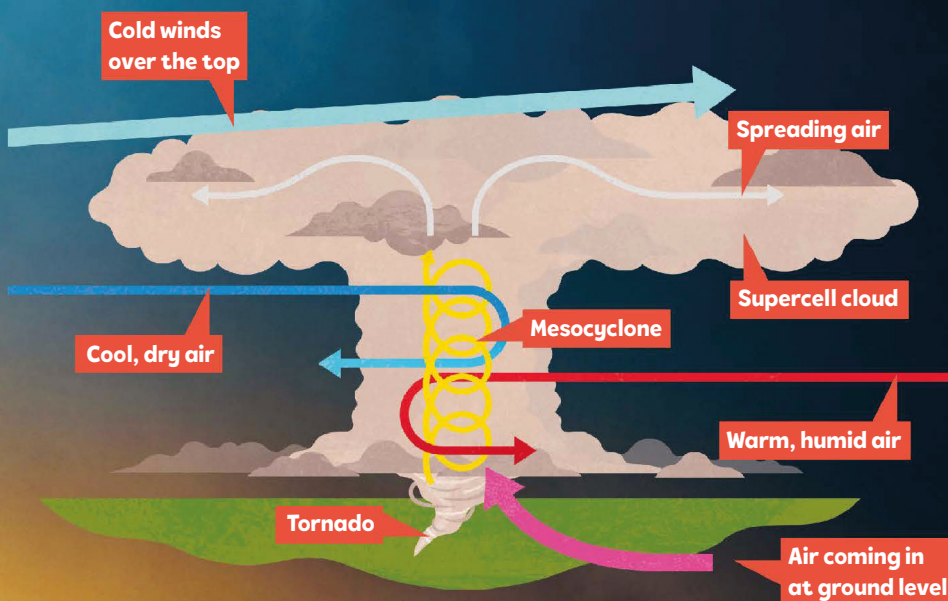
Funnel cloud descends from the supercell, rotating in ever-tighter circles as it gets closer to the ground.

STORM CHASERS

Some people are so fascinated by tornadoes that they risk their lives to see them up-close. American storm chaser Sean Casey, pictured right, built two armour-plated Tornado Intercept Vehicles (TIVs) to film inside a tornado. Sean's TIV has a camera turret, weather sensors, bulletproof windows and metal skirts to protect the underside of the vehicle from flying debris.

DID YOU KNOW?
In 2012, a tornado in Dallas, Texas, USA, tossed 18-wheel trucks into the air. The powerful tornado swept up the 30-tonne trucks as though they were toys.

HOW A TORNADO STARTS

Most tornadoes form when a strong updraft becomes a swirling column of air 10 to 20 kilometres across. This column, called a mesocyclone, rotates weakly at first but gets stronger and stronger as inflowing air stretches it upwards. It becomes a tornado when its spinning core hits the ground.

HOW TO MEASURE A TORNADO

The estimated wind speed and related damage caused by a tornado is measured on the Enhanced Fujita Scale (EF Scale). Ratings on the EF Scale run from EF0 to EF5, which is given to tornadoes with wind speeds higher than 200 mph, which can cause huge devastation.

WHAT TO DO IF A TORNADO STRIKES

The US National Weather Service gives the following advice:

GET IN
Go indoors, into the most interior room possible and away from doors and windows.

GET DOWN
Go to the lowest floor. Underground rooms are best.

COVER UP
Use whatever you can to shelter yourself from debris including clothing, helmets, pillows, blankets and mattresses.

Giant timeline of Britis

60 MILLION YEARS AGO

GIANT'S CAUSEWAY
Massive volcanic eruptions break apart European and North American continents, creating what is now the Atlantic Ocean. Giant columns of basalt rock condense into more than 38,000 natural geometric hexagonal shapes which look like the work of human or supernatural beings. The columns give rise to several legends, the most famous concerning Finn McCool, a giant who is said to have built the Causeway in a daring bid to reach his rival giant, Benandonner, in Scotland.

800,000 YEARS AGO

HUMAN ANCESTORS
Evidence of the oldest footsteps on British soil has been found in Norfolk. At this time Britain is connected and disconnected from mainland Europe as sea levels rise and fall during ice ages.

4,000 YEARS AGO

STONEHENGE
Stones such as those at Avebury and Stonehenge are erected by farming people. The precise purpose of these giant 'megalithic' monuments remains a mystery, but they may have been used as calendars or as sites for religious worship. Stonehenge is bought by Cecil Chubb in 1915 for £6,600. Three years later he gives the site to the nation.

c 1000 BCE
Celtic people etch the image of a horse on a chalk hill at Uffington.

800 BCE
Phoenician traders sail to Britain looking for minerals.

54 BCE
Ships appear off the coast of England as the Romans begin their conquest.

43 - 411 CE

ROMAN BRITAIN
Ships appear off the coast of Britain as, in 54 BCE, the mighty Roman Empire expands. Invasions occur throughout the next 100 years, ending with a successful conquest under Emperor Claudius in 43 CE. The Romans rule Britain as an imperial province for nearly 400 years, building new cities such as London, Colchester and Bath.

60 CE
Boudicca is defeated at Watling Street.

122 CE
The Emperor Hadrian builds a wall to protect against invading Scots.

597 CE
Benedictine monk Augustine converts Kentish people to Christianity.

600 CE
Sutton Hoo ship burial.

BOUDICCA (d. 61 CE)

OFFA (757-796)

EGBERT (802-839)

ALFRED THE GREAT (871-899)

CONSTANTINE II (900-943)

875 CE
Viking raiders sack the Holy Island of Lindisfarne.

sh history!

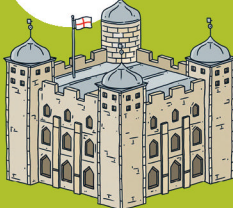
To celebrate King Charles III's coronation, we travel back in time to relive some of the most exciting and important moments in British history. Illustrations by Andy Forshaw

793 CE

VIKING INVASIONS
Scandinavian raiders appear off the Northumbrian coast. They loot and burn settlements on the north-east coast of Britain, beginning with a monastery on the Holy Island of Lindisfarne. By 867 CE Viking raiders settle in the east and make York their capital.

878 CE
King Alfred is said to have burned cakes while watching an oven for an old lady.

975 CE
The epic poem *Beowulf* tells the story of a hero mortally wounded while killing a dragon.

1087
Tower of London.

1051
Edward the Confessor allegedly promises the English crown to William, Duke of Normandy.

1215

MAGNA CARTA
On 15 June King John is forced to agree to a charter with rebellious barons. It guarantees the freedom of the Church and limits the power of the King to raise tax without his nobles' permission. A council of 25 barons is established to oversee its clauses. For 800 years Magna Carta is a rallying point for people seeking to limit the power of the state in the UK, America and across the world.

WILLIAM I (1066-1087)

WILLIAM II (1087-1100)

HENRY I (1100-1135)

STEPHEN (1135-1154)

HENRY II (1154-1189)

RICHARD I (1189-1199)

JOHN (1199-1216)

HENRY III (1216-1272)

EDWARD I (1272-1307)

EDWARD II (1307-1327)

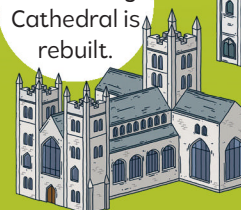
EDWARD III (1327-1377)

1066

NORMAN CONQUEST
William of Normandy defeats King Harold Godwinson at Hastings, shortly after Harold has repelled another invasion at Stamford Bridge by Harald III of Norway. William's victory is celebrated in a 70m-long embroidery called the Bayeux Tapestry.

1077
The Bayeux Tapestry.

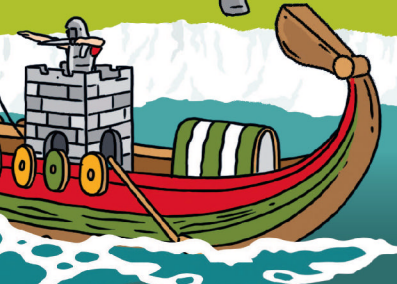
1170
Archbishop Thomas Becket is murdered outside Canterbury Cathedral.

1174
Canterbury Cathedral is rebuilt.

1245
Westminster Abbey.

1085
Doomsday Book.

1260
The story of George and the Dragon is first told in *The Golden Legend* by Italian storyteller Jacobus de Voragine.

1350
The Black Death kills millions of people.

1120
Henry I's only son William is drowned at sea.

1190
Richard the Lionheart leads his troops to Jerusalem in the Third Crusade.

1346
English forces use gunpowder for the first time at the Battle of Crécy.

1507
The Birdman of Stirling tries, and fails, to fly to France.

1483
Death of the Princes in the Tower.

1441
King's College Chapel, Cambridge.

1472
William Caxton brings the moveable-type printing press to Britain.

1603

UNION OF CROWNS
James VI of Scotland is crowned James I of England. Although the kingdoms are ruled separately for the next 104 years, this dynastic union of crowns lays the foundations for the creation of the United Kingdom.

1590 - 1613
William Shakespeare writes 38 plays.

1605
Guy Fawkes fails with his Gunpowder Plot.

1642 - 1649

THE CIVIL WAR
A bitter civil war breaks out after Charles I ignores the will of Parliament and asserts his ancient 'divine right' to rule as he pleases. Tension between royalists, parliamentarians, Protestants and Catholics spills over into war which ends only with the execution of King Charles in 1649. A new type of government, ruled by Puritan leader Oliver Cromwell, is in power for 11 years before the monarchy is restored in 1660 with the coronation of King Charles II.

RICHARD II (1377-1399)

HENRY IV (1399-1413)

HENRY V (1413-1422)

HENRY VI (1422-1461 / 1470-1471)

EDWARD IV (1461-1483)

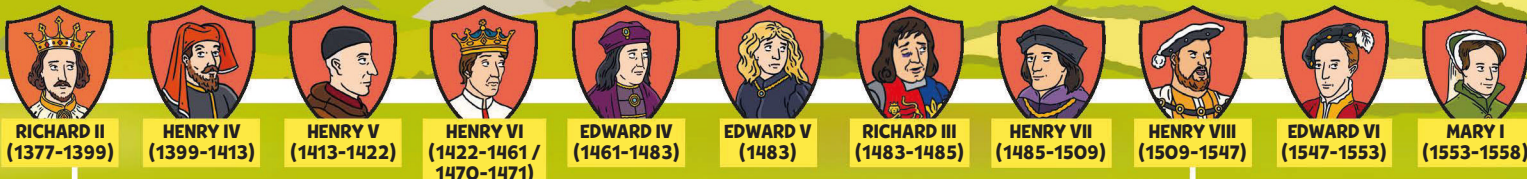
EDWARD V (1483)

RICHARD III (1483-1485)

HENRY VII (1485-1509)

HENRY VIII (1509-1547)

EDWARD VI (1547-1553)

MARY I (1553-1558)

1381

PEASANTS' REVOLT
Peasants protest against punitive taxes imposed after the fall of populations following the Black Death. Wat Tyler, the leader of the revolt, is beheaded by the King's men. From now on, ordinary people are better able to demand wages instead of having to provide military service, spelling the end of the feudal age.

1514
Hampton Court.

1527 - 1590

ENGLISH REFORMATION
Frustrated at not being granted a divorce from his first wife, Catherine of Aragon, Henry VIII declares himself Supreme Head of the Church of England. He confiscates 625 monasteries and 200 friaries. He spends much of his new wealth building 27 new vessels that form the backbone of the new Royal Navy. From now on Britain becomes a major naval power.

1545
Tudor flagship the *Mary Rose* sinks in the Solent.

1580
Sir Francis Drake, as captain of the *Golden Hinde*, is the first English person to circumnavigate the globe.

1588
The Spanish Armada is defeated.

1660
Samuel Pepys begins writing his famous diary about life in London.

1662
Scientists are given a royal charter by King Charles II.

1687
Isaac Newton's book *Principia* on gravity and three laws of motion is published.

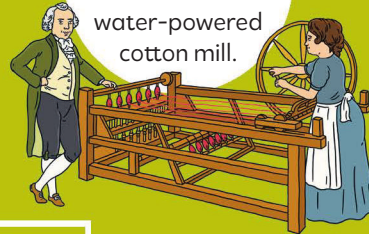
1701

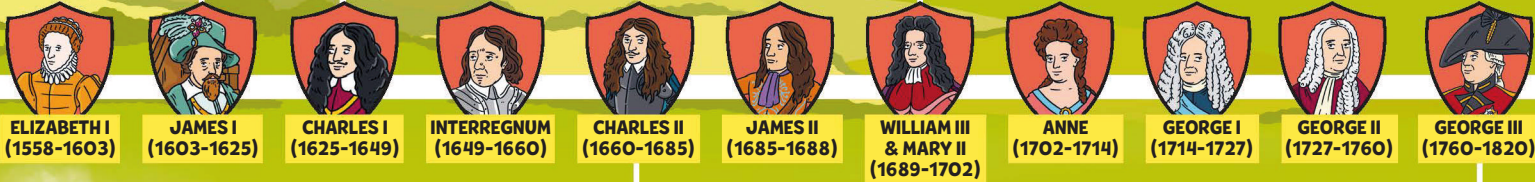
ACT OF SETTLEMENT

Parliament passes a law disqualifying any Roman Catholic, or anyone who marries a Roman Catholic, from inheriting the thrones of England and Ireland. As a result, Sophia of Hanover becomes heiress to the throne, but she dies two months before she would have become Queen. Six years later, the Acts of Union join the kingdoms of England and Scotland into the United Kingdom of Great Britain. The Union ensures a Protestant monarch will rule both countries.

1705
Edmond Halley calculates how long short-period comets take to return.

1721
Robert Walpole becomes Britain's first Prime Minister.

1786
Bolton barber Richard Arkwright builds a water-powered cotton mill.

1807 - 1833
William Wilberforce leads a campaign to abolish slavery.

ELIZABETH I (1558-1603)
JAMES I (1603-1625)
CHARLES I (1625-1649)
INTERREGNUM (1649-1660)
CHARLES II (1660-1685)
JAMES II (1685-1688)
WILLIAM III & MARY II (1689-1702)
ANNE (1702-1714)
GEORGE I (1714-1727)
GEORGE II (1727-1760)
GEORGE III (1760-1820)

1666

GREAT FIRE OF LONDON

A small fire at Thomas Farriner's bakery in Pudding Lane in London grows into the biggest blaze in British history. The fire is discovered shortly after midnight on 2 September and spreads rapidly across the city. It destroys everything in its path, including the original St Paul's Cathedral. A new London, mostly built of brick and stone, springs from the ashes.

1669
St Paul's.

1759
John Harrison invents a marine chronometer that measures time at sea accurately.

1815

DEFEAT OF NAPOLEON

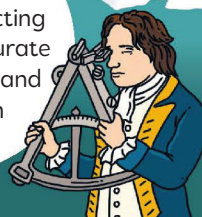
British forces under the command of Arthur Wellesley, Duke of Wellington, defeat French leader Napoleon near Waterloo, Belgium. Ten years earlier, Admiral Horatio Nelson defeats the French at the Battle of Trafalgar. Wellesley's victory is marked with a triumphal arch erected at Hyde Park Corner in London and Nelson's with a column in a London square.

1620
A group of 102 colonists sails from Plymouth on the *Mayflower* and settles in North America.

1734
John Hadley makes a reflecting octant for accurate time-keeping and navigation at sea.

1829
The Met Police force is created by Sir Robert Peel.

1905
Children's author Beatrix Potter leaves her estates in Cumbria to the National Trust.

1940
British and German warplanes clash in the Battle of Britain.

1829
HIGH PRESSURE STEAM
George Stephenson's *Rocket* wins a race to decide which locomotive should be used on a railway connecting Liverpool and Manchester. High-pressure steam, pioneered by Richard Trevithick, means people can move heavy loads from one place to another without relying on nature. Steam replaces water-power in mills and factories. The technology revolutionises the British economy.

1860
Florence Nightingale establishes the first school of nursing.

1918
T.E. Lawrence attempts to create a peace deal in the Middle East.

1913 - 1928
SUFFRAGETTES
Women campaign for the vote. Suffragette Emily Davison tries to pin a 'Votes for Women' banner on to the King's horse at the Epsom races but is fatally injured. Women finally achieve the right to vote on the same terms as men in 1928.

1925
Scottish engineer John Logie Baird makes the first public television demonstrations.

1939 - 1945
WORLD WAR II
World War II breaks out following the rise of Nazi Germany. Britain and its Allies emerge victorious but the country is bankrupt and the fall of its Empire accelerates with the granting of Indian independence in 1947.

GEORGE IV (1820-1830)

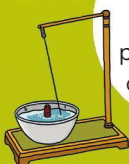
WILLIAM IV (1830-1837)

VICTORIA (1837-1901)

EDWARD VII (1901-1910)

GEORGE V (1910-1936)

EDWARD VIII (1936)

1821
Michael Faraday shows the potential uses of electricity.

1851
The Great Exhibition, the brainchild of Prince Albert, is held in the Crystal Palace.

1914 - 1918
WORLD WAR I
This four-year conflict, triggered by the rise of Germany as a European superpower, leads to the deaths of more than 9 million soldiers and 13 million civilians.

1822
Charles Babbage designs and partly builds the world's first mechanical computer.

1859
Charles Darwin publishes *On the Origin of Species*.

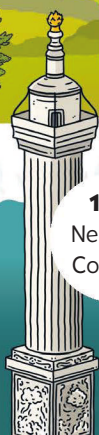
1944
Tommy Flowers makes the Colossus computer, used to crack codes in WWII.

1868
Benjamin Disraeli becomes the UK's first Jewish PM.

1870
Houses of Parliament.

1945
Wartime PM Winston Churchill celebrates Victory in Europe (VE) Day.

1838
Isambard Kingdom Brunel opens the Great Western Railway.

1843
Nelson's Column.

1912
Titanic – a ship said be 'unsinkable' – sinks on her maiden voyage after striking an iceberg.

1948
492 passengers sail from Jamaica to make new lives in Britain on board HMT *Empire Windrush*.

1950
Alan Turing devises a test to determine if a machine exhibits intelligence.

1966
England win the football World Cup, beating Germany 4-2 in the final.

1998
The Angel of the North, sculpted by Antony Gormley, is unveiled beside the A1 near Gateshead.

1997
Princess Diana dies in a car crash.

1963
The Beatles' John Lennon and Paul McCartney write many of their early songs.

1986
Margaret Thatcher, Britain's first female Prime Minister, signs an EU act aiming for a more united Europe.

2000
The Millennium Dome is built to house an exhibition marking the start of a new millennium in the year 2000.

2022

PLATINUM JUBILEE
Queen Elizabeth II celebrates her Platinum Jubilee, which marks the 70th anniversary of her becoming Queen in 1952. When she died in September of the same year, Elizabeth II was the second longest-reigning monarch in world history.

CHARLES III (2022-PRESENT)

The coronation of King Charles III and Queen Camilla takes place at Westminster Abbey in London on 6 May. Charles is to be crowned with the 360-year-old St Edward's Crown, which features 444 precious and semi-precious stones.

GEORGE VI (1936-1952)

ELIZABETH II (1952-2022)

1989

WORLD WIDE WEB
British computer scientist Tim Berners-Lee invents the World Wide Web, a system of interlinked computer files accessed by a web browser. His invention helps transform the Internet into the most powerful new communications technology since the invention of Gutenberg's printing press in the 1440s.

2011
Prince William and Kate marry.

2013
Andy Murray becomes the men's singles champion at Wimbledon.

2021
Captain Tom Moore raises millions for the NHS by walking around his garden.

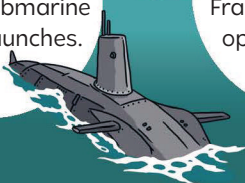
2012
The Olympics are held in London for the third time.

2015
British astronaut Tim Peake reaches the ISS.

2022
The England 'Lionesses' win the football Euros.

2015
Floods hit the North of England and Scotland, causing £5 billion of damage.

2016
Britain votes to leave the EU.

1994
The Trident nuclear submarine system launches.

1994
Queen Elizabeth II and French President François Mitterrand open the Channel Tunnel.

2012
Queen Elizabeth II celebrates her Diamond Jubilee.

2022
Explorer Ernest Shackleton's ship *Endurance*, lost in 1915, is found.

4

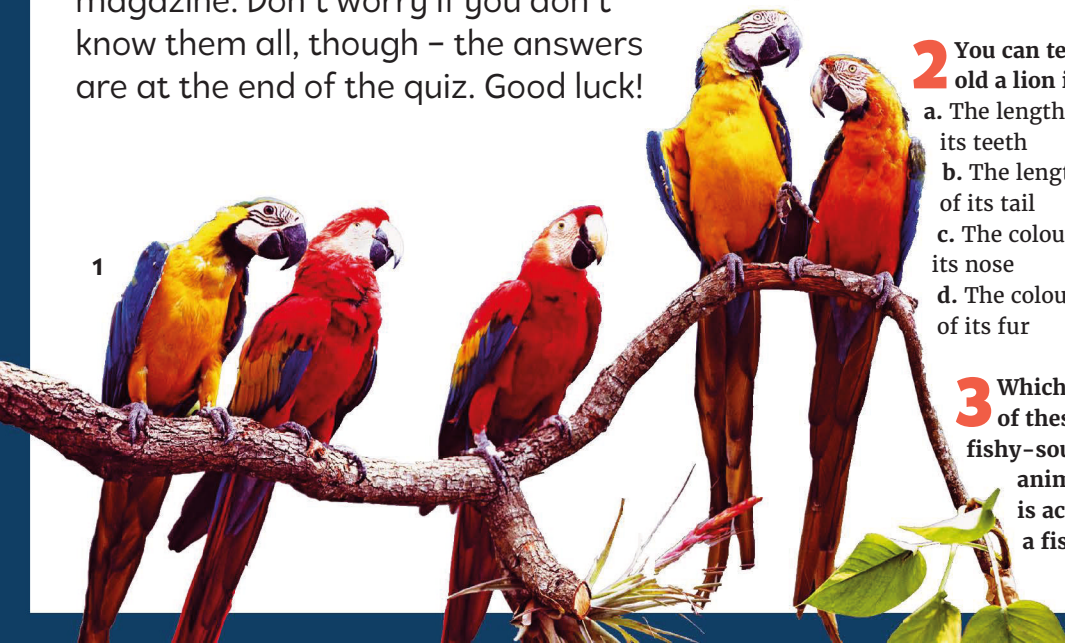
The BIG Britannica

Test your family's brainpower by playing this special four-page edition of the Big Britannica Quiz! Regular readers of Britannica Magazine may have an advantage because some of the facts appeared in previous issues of the magazine. Don't worry if you don't know them all, though – the answers are at the end of the quiz. Good luck!

ANIMALS

1 Which of these words is a collective name for a group of parrots?
a. Pandemonium
b. Flutter
c. Squawk
d. Chatter

2 You can tell how old a lion is by...
a. The length of its teeth
b. The length of its tail
c. The colour of its nose
d. The colour of its fur

3 Which of these fishy-sounding animals is actually a fish?

a. Jellyfish
b. Swordfish
c. Crayfish
d. Starfish

4 What colour is a polar bear's skin?
a. Black
b. Brown
c. White
d. Pink

5 How many legs does a lobster have?
a. 4
b. 6
c. 8
d. 10

6 Which animal has the most powerful sense of smell?
a. Shark
b. Elephant
c. Snake
d. Dog

SPACE & NATURE

7 As far as astronomers can tell so far, what is the most common type of galaxy?
a. Spiral
b. Barred spiral
c. Elliptical
d. Lenticular

8 Through which of these substances do sound waves move at the slowest speed?
a. Water
b. Air
c. Glass
d. Gold

9 Approximately how many planet Earths could you fit inside the Sun?
a. 1,200
b. 12,000
c. 120,000
d. 1.3 million

14

10 Which country contains the largest number of volcanoes – both active and dormant?
a. Russia
b. Iceland
c. USA
d. New Zealand

Family Quiz

10

11 What is the hardest naturally occurring substance on Earth?
a. Quartz
b. Platinum
c. Diamond
d. Tungsten

11

12 What colour are sunsets on Mars?
a. Red
b. Blue
c. Green
d. Purple

HUMAN BODY

13 During their lifetime, approximately how many years does the average human being spend asleep?
a. 4 years
b. 12 years
c. 24 years
d. 32 years

14 Approximately how many neurons, or brain cells, do adults lose each day that are never replaced?
a. None
b. 120
c. 1,200
d. 12,000

15 Which medical instrument do doctors use to listen to the beating of your heart?
a. Stethoscope
b. Horoscope
c. Endoscope
d. Telescope

16 What is nomophobia a fear of?
a. Numbers
b. Forgetting your own name
c. Being naked in public
d. Being without your mobile phone

17 What is the name of the type of tissue that connects muscle to bone?
a. Ligament
b. Tendon
c. Cartilage
d. Skin

18 What it the largest joint in the body?
a. Shoulder
b. Ankle
c. Knee
d. Elbow

Continued on next page ➤

22

➤ Continued from previous page

HUMAN WORLD

19 **In 1893, which country became the first to give all adult women the right to vote in national elections?**
a. UK
b. USA
c. Sweden
d. New Zealand

20 **Sisters Venus and Serena Williams are famous for...**
a. Playing football
b. Playing tennis
c. Acting
d. Gymnastics

20

21 **Alex Barron holds the world record for juggling the largest number of balls at the same time. How many balls did he juggle?**
a. 7
b. 9
c. 11
d. 13

22 **The Bugatti Chiron Super Sport 300+ is the world's fastest car designed to drive on normal roads. What is its top speed?**
a. 174 mph
b. 204 mph
c. 254 mph
d. 304 mph

23 **Which famous artist painted the ceiling of the Sistine Chapel in Rome?**
a. Michelangelo
b. Picasso
c. Rembrandt
d. Van Gogh

24 **How many books are there in the Harry Potter series by J.K. Rowling?**
a. 5
b. 6
c. 7
d. 8

GEOGRAPHY

25 **Which country**

23

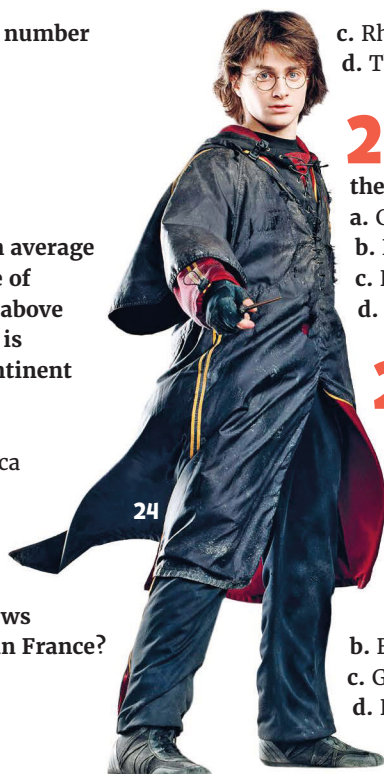
25

has the largest number of castles?

a. England
b. China
c. Russia
d. Germany

26 **With an average altitude of 2.5 kilometres above sea level, what is the highest continent on Earth?**

a. Europe
b. North America
c. Asia
d. Antarctica

27 **Which river flows through Paris in France?**

a. Seine
b. Tiber
c. Rhine
d. Thames

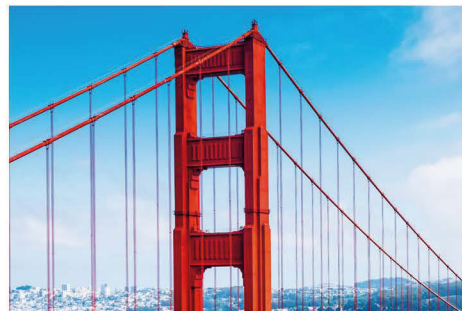
28 **Which animal appears on the flag of Sri Lanka?**

a. Goat
b. Lion
c. Eagle
d. Bear

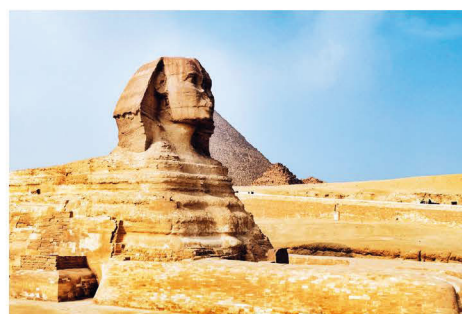
29 **What is the largest landlocked country, which means it doesn't border any seas or oceans and is surrounded by other countries?**

a. Mongolia
b. Ethiopia
c. Germany
d. Kazakhstan

30 **In which countries can you find the following famous buildings and landmarks?**

A

B

C

D

E

Answers: 1. a, 2. c – a lion is born with a pink nose but as it ages, black spots appear which gradually increase in size and number until its nose is completely black, 3. b, 4. a, 5. d, 6. b, 7. c, 8. b – sound moves through solids much faster than it does through liquids or gases, 9. d, 10. c, 11. c, 12. b, 13. c, 14. d, 15. a, 16. d, 17. b, 18. c, 19. d, 20. b, 21. c, 22. d, 23. a, 24. c, 25. d, 26. d, 27. a, 28. b, 29. d, 30. A – Golden Gate Bridge, USA; B – Uluru or Ayers Rock, Australia; C – Taj Mahal, India; D – Sphinx, Egypt; E – Machu Picchu, Peru.

IS THERE ALIEN LIFE?

For thousands of years, people on Earth believed our planet was special because they thought it was the only planet with life. Over the past few decades, however, scientists have made lots of discoveries that suggest Earth may not be as unique as we thought. Even so, it's still our special home.

Exoplanets

In 1992, astronomers discovered the first confirmed exoplanets. These are planets that orbit a star outside of our solar system. Since then, astronomers have identified more than 5,000 exoplanets orbiting other stars in our galaxy, and the number keeps growing every day.

Kepler-186f

Kepler-186f was the first Earth-sized exoplanet found in the habitable zone of a star. This is the region around the star where conditions are right for liquid water to form, just like on Earth. The discovery of Kepler-186f proved that there were other planets similar to Earth in our galaxy.

Kepler-438b

Initial investigations have shown that this exoplanet is the most similar to Earth yet discovered. It's very similar in size, only about 12% bigger than our planet. Scientists can't be sure yet, but the temperature on the surface could be between 0 and 60°C (32–140°F). One big difference to Earth would be the length of a year – just 35 days on Kepler-438b. More recent studies have shown that the exoplanet's host star sends out regular 'superflares'. These emissions would probably make it too dangerous for life to develop.

Are We Alone?

Back in 1961, astronomer Frank Drake was searching space for signals from other intelligent life forms. He wondered what the chance of finding another planet like Earth in the Milky Way galaxy was. To come up with a reasonable guess, he developed a mathematical formula that we now call the 'Drake Equation'. The equation starts with the 100 billion stars in the Milky Way. Then it cuts that total down using different factors to work out how many planets there might be in the galaxy with life forms on them capable of communicating with us. Astronomers now estimate that there may be 60 billion planets in the Milky Way with some type of life form on them. Only time will tell if some of them will give us a call!

Space Invaders

Astronomers have recently discovered signs of complex organic molecules out in space in giant dust clouds. These are similar to some of the chemical building blocks that make up living cells on Earth. One idea about the origin of life suggests that it got its start from chemical compounds like these brought to Earth on meteorites, asteroids and comets. This theory is called panspermia. In the past, the idea of the building blocks of life hitching a ride to our planet was pure science fiction. But there is growing evidence to suggest that it is a real possibility. And, if it happened here on Earth, it could have happened on other planets, too.

Sutter's Mill Meteorite

In April 2012, a meteorite struck California, USA, near Sutter's Mill. This is the same site that sparked the California Gold Rush of 1849. While this rock from space did not contain gold, when scientists analysed it they found a number of chemicals commonly associated with simple life forms. This discovery added to the idea that life on Earth may have got its start from objects in space.

EXCERPTED FROM *EARTH IS BIG*, WRITTEN BY STEVE TOMECEK AND ILLUSTRATED BY MARCOS FARINA

Absolutely Everything!

Each month we feature an amazing story from history taken from the bestselling book by Christopher Lloyd, with illustrations by Andy Forshaw.
This month: prehistoric plants and fungi!

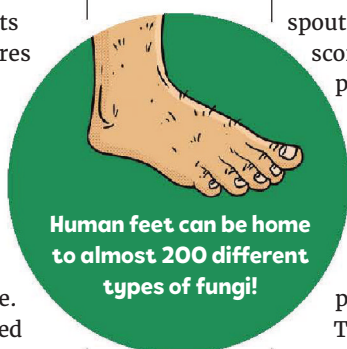
It was raining. It had rained the day before, and the day before that, too. For millions of years, life swarmed in the seas and rain hammered the land. There was nothing to see except lifeless rock and mud.

Then, about 470 million years ago, a little bit of green appeared. The first land plants were growing near the water's edge. These were squidgy liverworts and mosses. They had evolved from green algae, a water plant still around today. Like all plants, these used photosynthesis to make the energy they needed.

Next came a new type of plant that could grow much taller. They had a system of tubes to carry food and water from the ground to the tops of their bodies, a bit like the way we transport blood around our body in our blood vessels. We call these plants vascular plants.

The first vascular plants were just a few centimetres high, with thick stems. We know about them from an accidental discovery made in 1912 by William Mackie, a Scottish doctor, when he was out and about near the village of Rhynie. Quite by chance he spotted some curious-looking fossils in an old stone wall. You see, it turns out that about 400 million years ago Rhynie was a steaming cauldron.

Left: an artist's impression of early vascular plants (*Rhynia*) and giant fungi (*Prototaxites*) growing around 420 to 395 million years ago. The *Rhynia* plants were up to 20 cm tall, and the *Prototaxites*' trunks rose as high as 8 metres!

Human feet can be home to almost 200 different types of fungi!

There were boiling-hot pools of bubbling mud. Every so often a giant geyser would spout out a huge fountain of scorching water on to nearby plants. When the water landed on the plants, minerals in it cooled and turned them into stone. When this happens it is called petrification. That's where the word petrified comes from.

The fossils of Rhynie are so well preserved that scientists can see exactly what these ancient plants were made of and how they worked. It is clear that they contained

a substance called lignin. Lignin toughens the walls of plant cells. It makes the walls waterproof so the tubes inside the plant can carry water up to the top of a high tree. It's like having plastic tubing instead of tubing made from tissue paper.

Lignin makes trees woody and keeps them standing upright. But it took at least 40 million years for these small vascular plants to evolve into proper trees. They never could have made it to these heights were it not for another group of living things, called fungi.

Do you like mushrooms? I have to say they don't score very high on my list of tasty snacks. But researching and writing this article has turned me into a big mushroom fan. That's because without fungi (the giant group, or kingdom, of living things to which mushrooms belong) the world would be a disgusting and very smelly place.

We don't know much about the origin of fungi. We don't even know if they started life in the sea or on land. That's because their soft bodies don't leave many fossils behind. But we are pretty sure that fungi were already living on land when plants got there. Since then, fungi have developed

Continued on next page ➤

Above: a fossilised section of a prehistoric *Rhynia* plant, discovered near the Scottish village of Rhynie.

Above: pigs are able to sniff out truffles, which are a type of tasty mushroom that grows underground.

➤ Continued from previous page

into a huge variety of life forms, from some of the smallest to the largest living things on Earth.

Small fungi are just one cell. The yeast that makes bread rise is one of those. Large fungi are some of the biggest living things on Earth. One fungus in the state of Oregon, USA, is estimated to stretch out underground across nearly ten square kilometres – which is equivalent to more than 1,300 football pitches!

Fungi feed on other organisms just as animals do. Most fungi are made up of an underground network of root-like threads called a mycelium. The mushroom is just the part of the fungus that pops up above ground. The mushroom's job is to spread spores. These tiny reproductive cells get blown by the wind, then settle themselves and grow new fungi identical to their single parent.

Fungi are vital for all life on Earth because they eat dead things. Without them the world would be drowning under piles of the dead bodies of plants and animals – not a happy thought. They also make chemicals that help plants to grow.

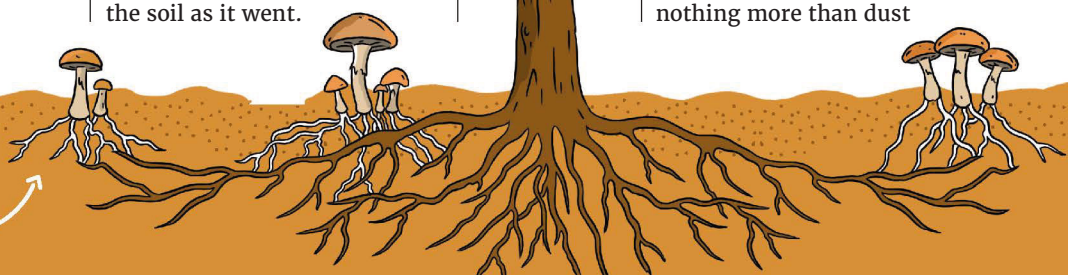
Sometimes nature has a real fondness for teamwork. Big networks of underground fungi pass nutrients and water to the roots of trees. In return, trees supply fungi with food. Thanks to ancient fungi, primitive plant life was able to move further inland, enriching the soil as it went.

Soil is made up of sand, minerals and the decayed remains of once-living things. Plants, tiny animals including worms, and fungi all help keep this precious life force working.

The fungi turn fallen leaves and rotting trees into nutrients to help new plants grow. They have been digging up the soil for the last 400 million years. And all that digging mixes the soil, renewing and regenerating it. This is called the soil cycle.

In fact, without living things, there would be no soil. The Earth would be nothing more than dust

The poisonous death cap is the deadliest known mushroom to humans.

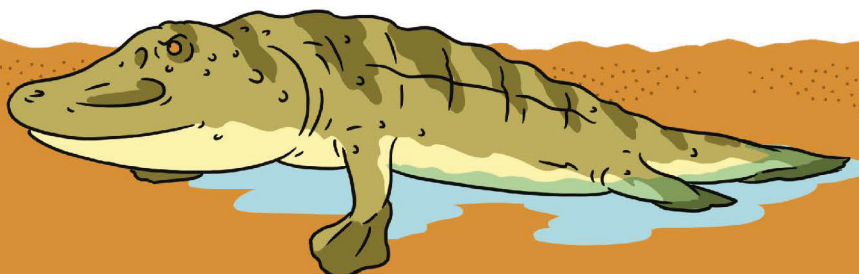
In a process called mycorrhiza, fungi supply water and minerals to a plant, and the plant provides the fungi with sugar it makes using photosynthesis.

DID YOU KNOW?
Some mushrooms glow in the dark. They do this to attract insects that help the mushroom to reproduce by spreading its spores to other parts of the forest.

and rock, like the surface of the Moon, Mars or Venus.

Fungi and plants were not the only organisms to move on to land. A few small crawly creatures emerged about 440–420 million years ago.

The first ever land animal was probably an arthropod. This group includes millipedes, insects, spiders, crabs, lobsters and a whole lot of other creatures with jointed legs and hard outer parts called an exoskeleton.

It took about 50 million years before another kind of animal made the move on to land. If you were a fish living in the seas back then, life could be over fairly quickly. Stinging jellyfish, sea scorpions with deadly tail spikes and giant placoderms were just a few of the dangers swimming around. If you were able to get out of the water, you might have had a better chance of surviving. After all, the shores were now full of plants and juicy worms to eat.

***Tiktaalik*, below, had wrist bones for lifting its body off the sea floor, lungs for breathing air, and a strong ribcage and neck.**

Fish aren't built to live on land, though. One problem is breathing oxygen from air instead of water. Another is working out how to move around. Imagine walking on fins instead of legs – it wouldn't be a simple walk in the park.

Tiktaalik, which is illustrated at the bottom of this page, found a way around this. It used its fins to wade through shallow bogs and to heave its body out of water on to the land. Which means *Tiktaalik* is the first creature ever known to have been able to do a press-up!

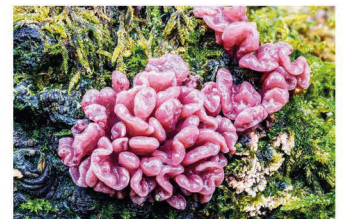
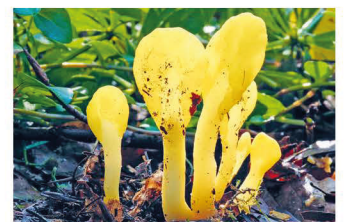
Tiktaalik lived about 375 million years ago, when primitive plants were growing near the shores. Its fossils show how fish-like fins were now being used as the first real arms, shoulders, elbows and wrists.

It's bizarre to think that the reason you and I have wrists and ankles goes all the way back to creatures such as *Tiktaalik*. That's because they needed hinged joints to heave their bodies up off the ground. Do a press-up yourself and you'll see just how important these hinges are!

Tiktaalik is one of the first of a group of animals known as amphibians. *Amphi* in ancient Greek means 'both' and *bios* means 'life'. They live both in the water and on the land. Not only could the first amphibians walk on land, they could also breathe through primitive lungs rather than using gills like fish. Equipped with these new features, some amphibians, such as the two-metre-long *Eryops*, became the most dominant creatures on the land. They had staying power. Their descendants include modern frogs, newts and toads. ✦

FIVE WEIRD & WONDERFUL FUNGI

Bleeding tooth fungus
Nicknames for *Hydnellum peckii* include 'bleeding tooth' and 'strawberries and cream'.

Stinkhorn mushrooms
This stinky family of mushrooms smell like rotting meat or animal poo. Eugh!

Purple jellydisc fungus
Clusters of *Ascocoryne sarcoides* look a bit like parts of an animal's intestines.

Yellow earth tongue fungus
***Spathularia flavida* looks like a tongue sticking up from the ground – hence its nickname.**

Jelly rot fungus
Like jelly that you eat for pudding, *Phlebia tremellosa* wobbles when it is touched.

Most humans are right-handed, around 11% are left-handed, and less than 1% are ambidextrous, even though, in evolutionary terms, this is an advantage. But as for why more humans haven't evolved to use both hands equally well...

Ask the experts

Readers ask. Experts answer. Send your questions to: experts@britannicamagazine.com

GAVIN PRETOR-PINNEY
Founder of the Cloud Appreciation Society

Question: How much does a cloud weigh?
From Emily, age 7

Answer
This partly depends, of course, on how big the cloud is. Because clouds, as you've probably noticed, come in many different shapes and sizes.

So let's imagine that we're trying to calculate the weight of a medium-sized cumulus cloud, which is the type of white, fluffy cloud that you often see on a sunny day.

First, we must estimate the cloud's size. And a medium-sized cumulus cloud might be 1 km long, 1 km wide and 1 km high, giving it a total volume of one cubic kilometre.

Next, we need to estimate the weight of all the water droplets inside the cloud. Scientists have found that a cubic metre of a cumulus cloud contains half a gram of water, which is about the same weight as a large garden pea.

You can fit a billion cubic metres inside a cubic kilometre, which means that our medium-sized cumulus cloud contains 500 million grams – or 500,000 kilograms – of water. That is roughly the same weight as eighty African elephants!

So why don't clouds fall out of the sky, like elephants would? The reason is that although clouds often appear to be solid – because of the way they reflect sunlight – they aren't really solid, singular objects at all. Clouds are in fact vast collections of tiny droplets of water, with each droplet just one hundredth of a millimetre across.

The tiny size of these droplets means they can be lifted up and carried along by rising currents of warm air – which is why clouds remain buoyant and float in the sky. The fact that there are literally billions of water droplets inside each cloud means that, when you add all those droplets together, they can weigh more than a herd of elephants!

According to a scientific study of information from weather satellites, about 65 per cent of Earth's surface is typically covered by clouds.

DID YOU KNOW?
A single cubic metre of a cumulus cloud can contain 100 million tiny droplets of water.

Stumped? Don't worry, you can find the answers to all the puzzles on page 50.

ANIMAL WORD SEARCH

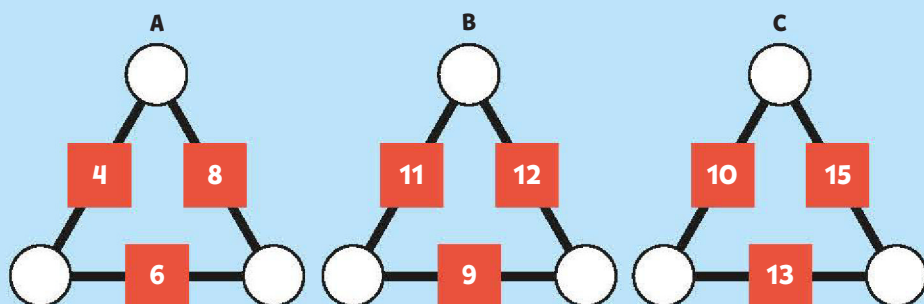
Can you spot the names of these 26 animals hidden in our jumbo word search puzzle? Good luck!

R	J	W	M	P	R	J	H	Q	O	G	N	I	M	M	E	L	F	Q	V
O	T	H	R	I	J	V	P	I	F	F	N	V	Q	H	F	G	B	U	T
T	S	D	P	E	L	A	G	N	I	T	H	G	I	N	L	N	C	K	C
A	F	A	R	W	B	W	C	A	V	B	W	N	T	K	X	A	Q	D	N
G	T	R	H	I	O	X	K	K	M	I	I	K	X	K	Y	A	Q	E	Q
I	T	K	I	S	B	O	P	D	A	L	Q	W	W	E	O	U	B	C	I
L	N	S	O	X	T	G	F	J	O	L	S	E	L	P	V	A	P	O	Q
L	Y	L	U	F	V	P	N	G	D	U	L	L	S	T	G	X	L	R	B
A	X	U	C	P	Z	J	N	I	R	L	O	B	Q	Q	O	G	Y	A	T
G	U	G	Z	P	S	A	Z	E	M	W	K	M	K	W	O	J	Y	T	F
V	H	A	O	W	P	Q	X	E	C	M	V	F	D	J	S	F	D	O	R
O	T	Q	U	A	I	L	W	R	B	Z	U	R	U	S	E	L	M	R	O
A	U	Z	K	S	S	H	A	S	M	R	R	H	L	G	X	E	F	C	G
O	L	M	E	P	I	Z	C	O	C	K	A	T	O	O	F	S	F	R	G
B	V	R	E	H	Y	K	B	L	Z	A	L	S	N	U	F	O	V	A	I
X	R	X	I	A	E	O	O	R	L	M	D	T	H	Q	O	O	L	B	W
K	M	D	N	I	F	L	N	F	W	E	W	U	I	A	V	M	G	Q	R
R	Y	T	U	R	A	L	O	W	L	W	V	E	R	O	R	Z	I	K	A
A	E	Z	D	X	T	S	B	V	I	B	I	S	J	W	H	K	L	U	E
R	A	C	C	O	O	N	O	H	T	Q	P	Z	X	O	F	L	Y	B	B

ALLIGATOR
BONOBO
COCKATOO
DECORATOR CRAB
EARWIG
FOX
GOOSE
HUMMINGBIRD
IBIS
JACKAL
KOALA
LEMMING
MOOSE
NIGHTINGALE
OLM
PANGOLIN
QUAIL
RACCOON
SLUG
TAPIR
URAL OWL
VOLE
WASP
XERUS
YELLOW CRAZY ANT
ZEBRA SHARK

NUMBER TRIANGLES!

In the triangles below, the numbers inside the squares are the sum of the two numbers in the connected circles. For example:

Can you work out which number should appear in each of the circles? All the numbers in the circles are between 1 and 9 and a number can only be used once in each triangle.

SPOT THE DIFFERENCE!

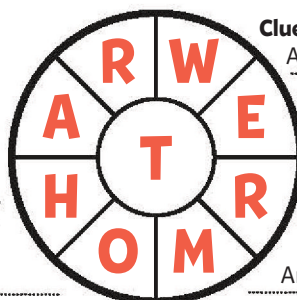
Can you spot all 20 differences between these two springtime illustrations?

WORD WHEEL

Use the word wheel to help find the answers to the six clues below. All the answers contain the middle letter, and each letter can only be used once.

R W E R M O H A (middle: T)

Clue: a long, thin animal that wriggles and burrows through the soil (9 letters).
Answer:

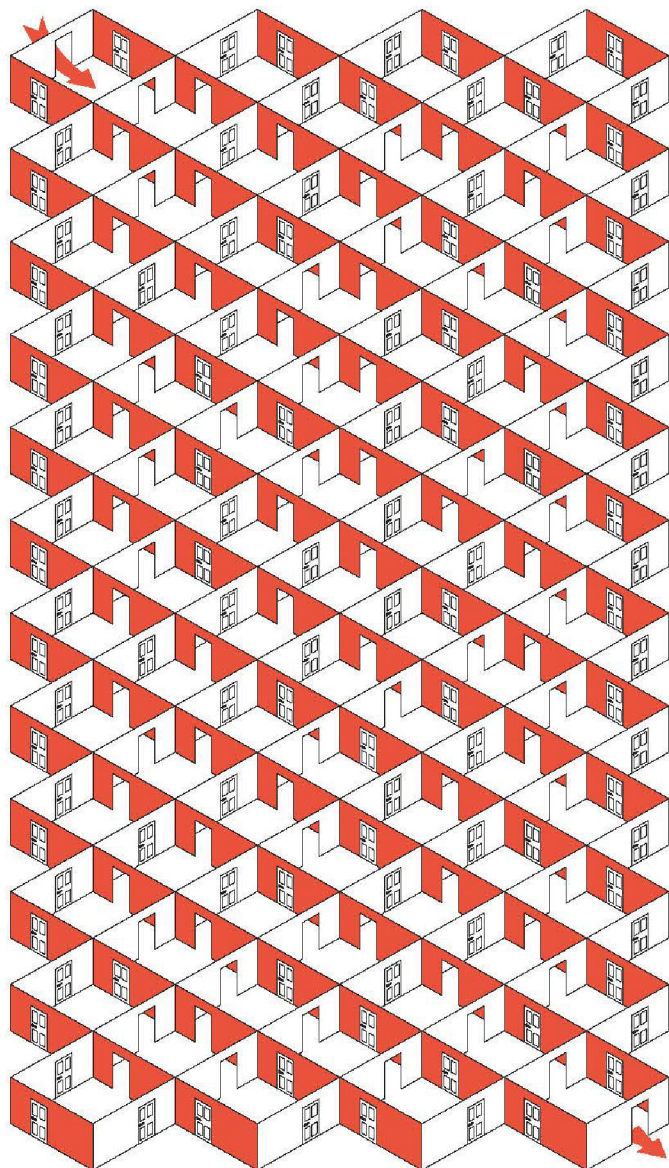
Clue: a decorative arrangement of flowers or leaves shaped into a ring (6 letters).
Answer:

Clue: the movement caused by a small earthquake (6 letters).
Answer:

Clue: a vital organ of the human body (5 letters).
Answer:

Clue: the most abundant liquid on Earth (5 letters).
Answer:

Clue: a winged insect that looks like a butterfly (4 letters).
Answer:

CHANGING ROOMS

Can you find your way through our maze of square rooms? Enter through the door marked with the red arrow, then try to find your way to the exit by going through the correct sequence of open doors. Good luck!

Picture Quiz

FUTOSHIKI!

Fill in the missing numbers so that every row and column includes the numbers 1, 2, 3 and 4. Use the inequality signs as clues and make sure numbers always obey the inequality sign between them. This means that the arrows between the numbers always point towards the smaller number.

Here is an example:

A < 3
∨
B

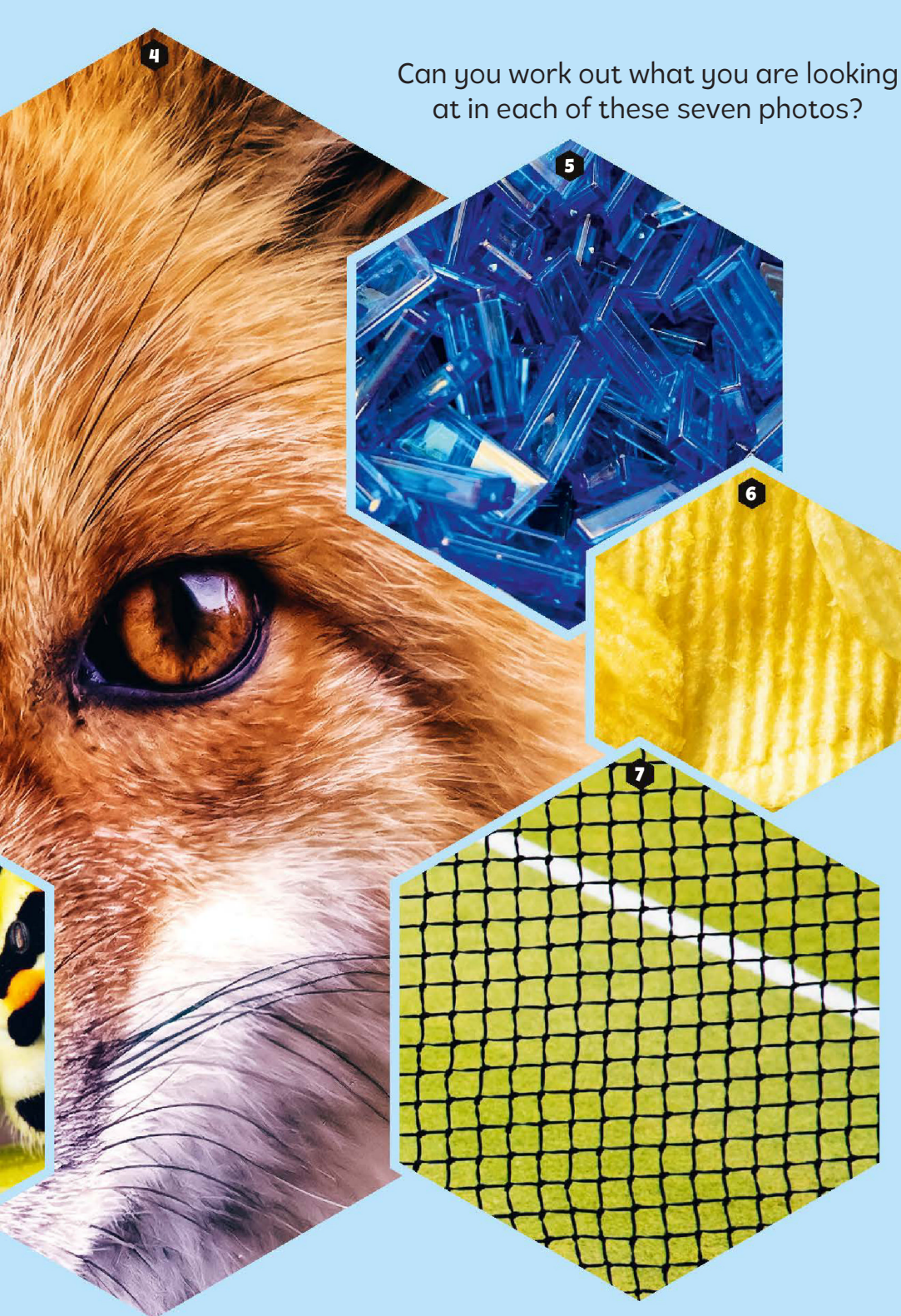
In the three squares shown above, the number A must be less than 3 and greater than the missing number B. We know all the numbers must be between 1 and 4 , so therefore A must be 2 and B must be 1.

A

4 >

B

2

3

Can you work out what you are looking at in each of these seven photos?

BRIDGE PUZZLE

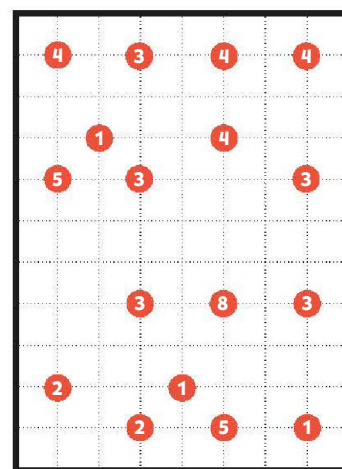
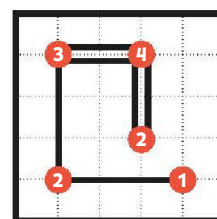
Draw bridges between the red islands so that the number of bridges connected to each island equals the number written inside the circle.

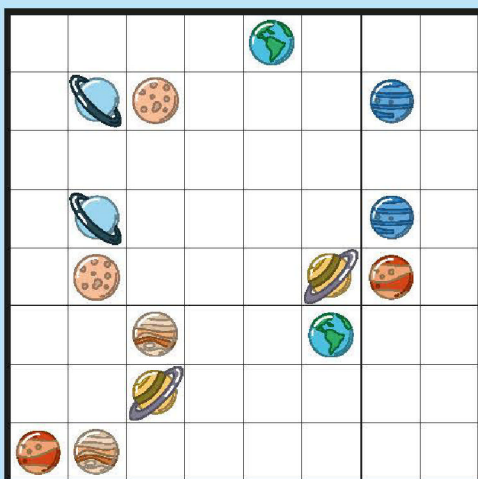
Rules:

1. The bridges must be straight lines and cannot bend.

2. The bridges cannot intersect with each other.

3. The bridges can be horizontal or vertical but not diagonal.

4. The maximum number of bridges connecting two islands is two.

CONNECT THE PLANETS

Draw a line to connect each pair of planets. You can't use diagonal lines and the lines can't cross or touch each other. You must fill the whole grid with lines but only one line is allowed in each square.

SUDOKU!

Fill all the empty squares so that every row, column and 3x2 box contains each of the numbers 1 to 6.

2			6		1
6	4	1			5
	3		4		2
		2			
3	2		5		6
5			3		

SEND IT IN!

YOUR fact of the month

Send your favourite fact to: facts@britannicamagazine.com

Zebras are attracted to combinations of black and white. So if black-and-white stripes are painted on a wall, zebras will stand next to it!

Submitted by Pranav, age 11.

A guided tour of the solar system!

This brilliant 'Poem of Space Facts' was sent in by Farah, age 9. Do you have a poem or photo you'd like to share with other readers? Then send it in!

Our galaxy is called the Milky Way,
Sometimes they come in different shapes today.
Spiral, Irregular, there's more I can tell,
Trust me, they're magical, just like a spell.

If you're an astronaut, you're the sailor of the stars,
If you go out into space, you might see Mars.
You can be loud in space as nobody can hear you,
So, you can say anything, even if you don't have a clue.

Mercury is warm, and Neptune is cold,
They are so cool, that they will never get old.
Saturn is as light as balloons,
And did you know it has 83 moons?

Out in the Milky Way, there is lots you can see,
Hopefully, there is an alien to guide a person like me!

Draw your own sea creature...

Use the underwater scene below to create your very own marine creature. We've added a pair of divers and the silhouettes of some other animals to get you started! When you've finished, send your drawing to: editor@britannicamagazine.com

If your **photo, drawing, letter or poem** is featured in a future issue of Britannica Magazine, you will win a copy of the brilliantly disgusting ***Gross Factopia!***
So don't delay and...
SEND IT IN!

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Editor
Andrew Pettie

Art & Design Director
Mark Hickling

Designer
Susanna Hickling

Production
Sarah Epton

Contributors
Kate Hale, Andy Forshaw, Andy Smith, Steve Tomecek, Marcos Farina, Christopher Lloyd, Andrés Lozano, Julie Beer, Susanna Hickling (including cover illustrations), May, Lisa Thomas, Chris Harrison

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Editorial Consultant
Nancy Feresten

Business Development
David Falzani

CEO, What on Earth Magazines
Christopher Lloyd

For Encyclopaedia Britannica
Alison Eldridge, Managing Editor

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Digital Marketing
Jamie French

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editor@britannicamagazine.com

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britannicamagazine.co.uk

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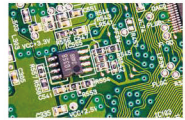
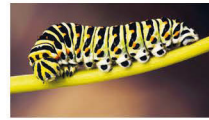
Puzzle Answers

Picture Quiz

Circuit board

LEGO bricks

Caterpillar

Fox

Tennis net

Crisps

Fidget spinner

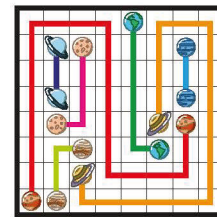
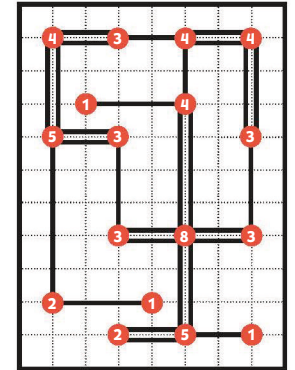
Animal Word Search

R	J	W	M	P	R	J	H	Q	O	G	N	I	M	M	E	L	F	Q	V
O	T	H	R	I	J	V	P	I	F	F	N	V	Q	H	F	G	B	U	T
T	S	D	P	E	L	A	G	N	I	T	H	G	I	N	L	N	C	K	C
A	F	A	R	W	B	W	C	A	V	B	W	N	T	K	X	A	Q	D	N
G	T	R	H	I	O	X	K	K	M	I	I	K	X	K	Y	A	Q	E	Q
I	T	K	I	S	B	O	P	D	A	L	Q	W	W	E	O	U	B	C	I
L	N	S	O	X	T	G	F	J	O	L	S	E	L	P	V	A	P	O	Q
L	Y	L	U	F	V	P	N	G	D	U	L	L	S	T	G	X	L	R	B
A	X	U	C	P	Z	J	N	I	R	L	O	B	Q	Q	O	G	Y	A	T
G	U	G	Z	P	S	A	Z	E	M	W	K	M	K	W	O	J	Y	T	F
V	H	A	O	W	P	Q	X	E	C	M	V	F	D	J	S	F	D	O	R
O	T	Q	U	A	I	L	W	R	B	Z	U	R	U	S	E	L	M	R	O
A	U	Z	K	S	S	H	A	S	M	R	R	H	L	G	X	E	F	C	G
O	L	M	E	P	I	Z	C	O	C	K	A	T	O	O	F	S	F	R	G
B	V	R	E	H	Y	K	B	L	Z	A	L	S	N	U	F	O	V	A	I
X	R	X	I	A	E	O	O	R	L	M	D	T	H	Q	O	O	L	B	W
K	M	D	N	I	F	L	N	F	W	E	W	U	I	A	V	M	G	Q	R
R	Y	T	U	R	A	L	O	W	L	W	V	E	R	O	R	Z	I	K	A
A	E	Z	D	X	T	S	B	V	I	B	I	S	J	W	H	K	L	U	E
R	A	C	C	O	O	N	O	H	T	Q	P	Z	X	O	F	L	Y	B	B

Spot the Difference!

Sudoku!

2	5	3	6	4	1
6	4	1	2	3	5
1	3	5	4	6	2
4	6	2	1	5	3
3	2	4	5	1	6
5	1	6	3	2	4

Connect the Planets

Bridge Puzzle

Word Wheel

1. Earthworm **2.** Wreath
3. Tremor **4.** Heart
5. Water **6.** Moth

Number Triangles!

A

B

C

Futoshiki!

A

4	3	1	2
2	1	3	4
3	2	4	1
1	4	2	3

B

3	1	2	4
4	2	1	3
2	4	3	1
1	3	4	2

Changing Rooms

Spy Puzzle Answers

Matchstick Maths

Turn the Cogs

Crack the Code

A) 1. Madrid **2.** London
3. Tokyo **4.** Paris **5.** New York

B) 1. Giraffe **2.** Snake
3. Raccoon **4.** Crocodile
5. Elephant

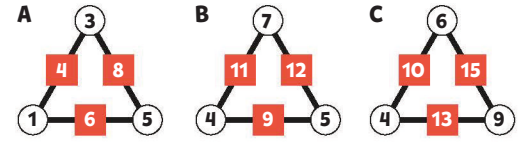
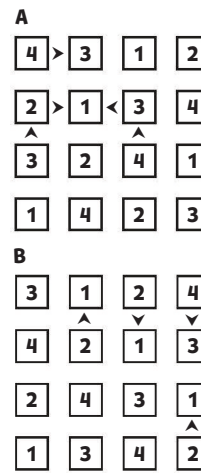
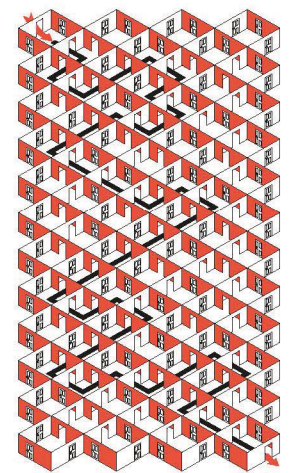
Find the Food

A. Ham **B.** Egg **C.** Plum
D. Rice **E.** Tart

Mirror Image

1-9, 2-8, 3-6,
4-10, 5-7

View From Above

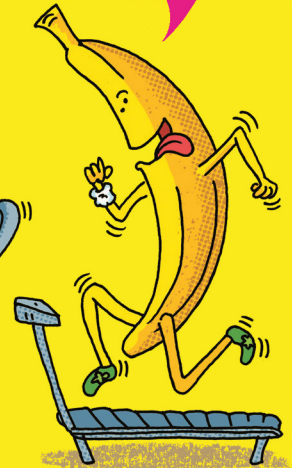
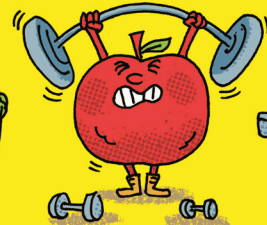
1-E, 2-A, 3-B, 4-C, 5-G, 6-D, 7-I, 8-H, 9-F

Jokes & riddles

Tickle your ribs and tease your brain with our favourite gags and riddles, hand-picked by our jokes editor May.

Why did the apple join the gym?

To build up its core strength!

Q **Why should you never believe a balloon?**
A Because it's full of hot air!

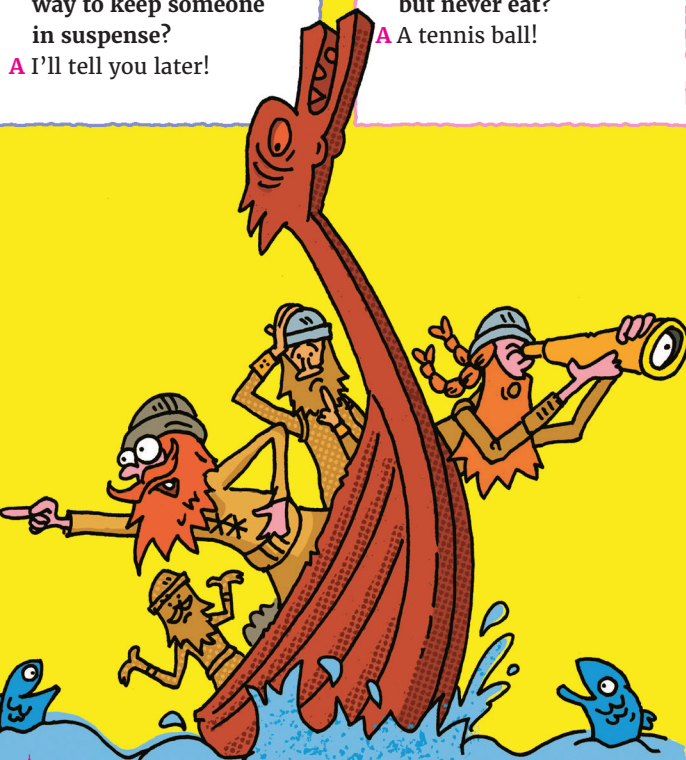
Q **I can honk without a horn. What am I?**
A A goose!

Q **What is the easiest type of lid to open?**
A Your eyelid!

Q **How do musicians like to drink lemonade?**
A Through an orche-straw!

Q **Which English word is always misunderstood?**
A Misunderstood!

Q **Where do you find a cow with no legs?**
A Right where you left it!

What is a kangaroo's favourite season?

Spring!

Q **What is the best way to keep someone in suspense?**
A I'll tell you later!

Q **What can you serve but never eat?**
A A tennis ball!

Q **Who earns a living driving their customers away?**
A A taxi driver!

Q **What do you get if you cross a ghost and a chicken?**
A A poultry-geist!

Q **Which word does not belong in this list: stop, crop, mop, chop, shop or crop?**
A Or!

Q **Why did the gherkin call for help?**
A It was in a pickle!

Q **What kind of dress is impossible to wear?**
A An ad-dress!

Q **How do skunks like to travel?**
A In a smell-icopter!

ILLUSTRATIONS BY ANDY SMITH